NEVADA DIVISION OF ENVIRONMENTAL PROTECTION
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STATE OF NEVADA
Department of Conservation & Natural Resources
DIVISION OF ENVIRONMENTAL PROTECTION

Brian Sandoval, Governor
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April 26, 2011

Irwin Kishner
Herman Kishner Trust
294 Convention Center Drive
Las Vegas, NV 89109

Maryland Square Shopping Center, LLC
c/o Tim Swickard
Dongell Lawrence Finney LLP
770 L St., Suite 950
Sacramento, CA 95814

Subject: **Draft Corrective Action Plan for Groundwater, Maryland Square Shopping Center**

Facility: Al Phillips the Cleaner (former)
3661 S. Maryland Parkway
Las Vegas, NV

Facility ID: H-000086

Dear Mr. Kishner and Mr. Swickard:

The Nevada Division of Environmental Protection (NDEP) has reviewed the draft Corrective Action Plan (CAP) for Groundwater, prepared by Tetra Tech on behalf of the Herman Kishner Trust (Trust) and Maryland Square Shopping Center, LLC. (MSSC), and received electronically by the NDEP on February 28, 2011, and in hard copy on March 14, 2011. In developing these comments, the NDEP has considered input provided by other parties to the NDEP, and, where determined appropriate by the NDEP, has included those comments in this letter. This letter and attachment provide the NDEP's comments on the draft CAP for groundwater.

General Comments

The NDEP noted some of the same issues with this version of the draft CAP for Groundwater (February 28, 2011) as for the previous version of the draft CAP (October 11, 2010). Primary concern focuses on several deficiencies, including **(1)** an inadequate evaluation of the existing data, **(2)** failure to specify data needs for each proposed alternative and provide a comparison with existing data to determine data gaps, **(3)** no conduct of a human health risk assessment (HHRA) using existing data.

1. The CAP is <u>a plan to provide a plan</u>. The CAP proposes to submit a work plan to collect additional data in a sequential schedule that does not allow adequate time for evaluation of all viable technologies within 180 days of CAP approval. Necessary data for all viable technologies should be collected concurrently, not sequentially.

2. The document <u>fails to adequately evaluate existing data</u> and proposes collection of additional data without specifying exactly what data are needed to make the decisions for evaluating and selecting the shallow groundwater remedy. Data needs for each remedy are not listed in the CAP; the following data exist:

a. There is a large data set for volatile organic compounds (VOCs) analyzed by Method 8260B for groundwater samples collected over several years from 33 wells

b. There is a large data set for field parameters, with more than 250 records for 31 wells

c. There is a moderately large data set for inorganic constituent in groundwater, based on numerous samples collected from 12 monitoring wells. As reported in Table 4 in the groundwater monitoring report for first quarter 2008 (URS, 2008)

d. There are indoor air data for 97 residences; with laboratory quality control (QC) data for validation of these data, which can then be used to perform an HHRA

e. The utility of subslab data is questionable (see Section 9.1 in the CAP); studies have shown extreme variability (orders of magnitude) across the slab. Additionally, there is an attenuation factor must be assumed if using subslab data to estimate "potential" risk. In contrast, a time-averaged sample of indoor air provides information on actual exposure. Care must be taken to avoid interference from background sources of VOCs in the home, but this is usually possible by conducting a home survey.

3. There are analytical data for samples of groundwater, soil, soil gas, and indoor air for the Site. **Unless data are rejected, they are usable.** It is unclear why these data are deemed "insufficient" in terms of quantity and quality to conduct a HHRA. The laboratory QC data are available to conduct validation of the indoor air data. The HHRA may be updated after additional data are collected and before remedy implementation.

As noted in the NDEP's letter of **January 11, 2011**, the remediation standard for PCE in groundwater should be the maximum contaminant level (MCL) or a level such that associated concentration of PCE in indoor air approaches a 10^{-6} risk level. The remediation standard for indoor air has not yet been determined.

Specific Comments

Detailed specific comments are provided in Attachment 1 to this letter.

NDEP Requirements

The NDEP considered how best to address the deficiencies of the draft CAP for Groundwater, but ultimately concluded that **the current draft CAP is unacceptable**.

Please provide responses to comments on the February 28, 2011 version of the draft CAP for Groundwater and provide an acceptable CAP for Groundwater no later than **June 14, 2011**

If you have any questions or require additional information regarding this letter, contact me by telephone at (775) 687-9496 or e-mail at msiders@ndep.nv.gov.

Sincerely,

Mary A. Siders

Mary A. Siders, Ph.D.
Bureau of Corrective Actions
Fax (775) 687-8335

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Enclosures (1)
Attachment 1 – Specific Comments

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ATTACHMENT 1 – SPECIFIC COMMENTS

Draft Corrective Action Plan for Groundwater, Maryland Square Shopping Center, Facility ID: H-000086

PART A: REQUIRED CRITICAL COMMENTS

Executive Summary

1. Page ES-1. The Nevada Division of Environmental Protection (NDEP) notes that the primary purpose of the Corrective Action Plan (CAP) is to establish a **process, schedule and criteria** by which a remedy for shallow groundwater will be evaluated and proposed for selection by the NDEP. A secondary purpose of the CAP is to propose **additional data collection, analysis and reporting** needed to complete remedy selection and start design. A relatively mature conceptual site mode (CSM) exists for the site, and should be included in discussions of human health risk.

2. Page ES-1. The text states that "*A baseline risk assessment predicting and quantifying potential human health risk will be presented in the final CAP after adequate data are obtained.*"

   As noted previously by the NDEP, it is unclear what aspects of the existing data are not adequate. The existing data appear adequate to conduct a draft risk assessment in this document. A screening-level risk assessment can then be used to determine what specific additional data, if any, are needed to complete the risk assessment.

3. Page ES-1. The preliminary corrective action objectives (CAOs) are listed here as:
   1. Prevent inhalation exposure of current residents to concentrations of PCE that exceed the remediation standard for residential indoor air.
   2. Prevent use of shallow groundwater as a source of drinking water and remediate shallow groundwater where PCE concentrations exceed the remediation standard for groundwater.

   Please revise to indicate that CAOs are to protect human health by reducing inhalation exposure to solvent vapors emanating from groundwater, and to protect and restore shallow groundwater in accordance with Nevada Administrative Code (NAC) 445A.22725

4. Page ES-1. The text states that "*General response actions (GRA) were identified using these preliminary CAOs and numerical remediation standards...*"

   The CAP should also develop working definitions of the specific areas and volume of groundwater targeted for cleanup and relate this to any other areas and timing for potential interim abatement for domestic well protection and additional mitigation of indoor air (refer to the ***Draft Work Plan for Mitigation of Indoor Air and Well Water***).

   The CAP should use the concept of preliminary remediation goals (PRGs) or regional screening levels (RSLs) for purposes of analysis and incorporate applicable concepts from the April 22, 1991 (U.S.

Environmental Protection Agency [USEPA] Role of Baseline Risk Assessment (Office of Solid Waste and Emergency Response [OSWER] Directive 9355.0-30) and the August 1997 Guidance Rules of Thumb for Superfund Remedy Selection (OSWER Directive 9355.0-69).

The NDEP notes that, in the absence of applicable or relevant and appropriate requirements (ARARs) for chemicals that pose carcinogenic risks, PRGs generally should be established at concentrations that achieve 10^{-6} excess cancer risk, modifying as appropriate based on exposure, uncertainty, and technical feasibility factors. Initial PRGs are developed early in the remedial investigation and feasibility study (RI/FS) process and are based on ARARs and other readily available information, such as concentrations associated with 10^{-6} cancer risk or a hazard quotient equal to one for noncarcinogens calculated from USEPA toxicity information. Initial PRGs may also be modified based on exposure, uncertainty, and technical feasibility factors. As data are gathered during the baseline risk assessment and RI/FS, PRGs are refined into final contaminant-specific cleanup levels. Based on consideration of factors during the nine criteria analysis and using the PRG as a point of departure, the final cleanup level may reflect a different risk level within the acceptable risk range (10^{-4} to 10^{-6} for carcinogens) than the originally identified PRGs. The final cleanup levels, not PRGs, are documented in the record of decision (ROD).

5. ES-2. Text refers to "*MNA as a polishing step*;" however, the attenuation currently observed in the plume appears to be almost solely the result of sorption and dispersion. The data indicate little in the way of dechlorination and degradation.

6. Page ES-2. Text states that "*If in-situ chemical oxidation or a sparge curtain is proven insufficient during testing, a zero-valent iron (ZVI) PRB, extraction and treatment, and/or enhanced bioremediation will be further evaluated*" and "*Until an adequate understanding of the environmental conditions and characteristics can be determined through bench-scale and pilot testing.*"

   The NDEP does not concur with sequential bench-scale and pilot-scale testing; the schedule should be revised so that tests for viable alternatives should be conducted concurrently, so as not to further delay progress toward implementing a remedy. Describe what data are needed for an "adequate understanding" and describe how that additional data will inform decisions regarding technology selection or remedial design.

7. ES-2. "*Based on a review of the existing data, additional data are needed for adequate description and understanding as follows: (1) Indoor air data are needed to evaluate current residential conditions and evaluate the efficacy of mitigation systems previously installed by the Nevada Department of Environmental Protection (NDEP)...*

   The NDEP notes there are indoor air data for 97 homes, along with multiple samples (before and after mitigation and system optimization) from homes where subslab depressurization (SSD) systems were installed. Annual sampling of indoor air of requesting homeowners within the plume area is required in the Permanent Injunction. (2010). Unless the existing data are invalid, there is no reason that these data cannot be used for a risk assessment. The risk assessment should be done using existing data, then updated as additional data are collected. Also, it is the Nevada Division of Environmental Protection (NDEP).

8. <u>ES-2, continued.</u> *(2)* ***Soil properties*** *have not been well characterized for the* ***unsaturated*** *and* ***saturated heterogeneous soils*** *across the Site. Insufficient* ***physical, flow****, and* ***contaminant distribution data*** *have been collected in the* ***unsaturated and saturated zones*** *beneath the Site."*

   The NDEP notes that **soil properties and contaminant distribution data** for the **unsaturated zone** in the <u>source area</u> **are well characterized** (29 borings and 77 soil samples analyzed).

   The NDEP notes that **detailed delineation** of the **lithology** and **vertical distribution of tetrachloroethylene (PCE)** in groundwater will be needed **in the area(s) where a remedy will likely be installed**. However, because of the size of the site and the known heterogeneity of the alluvial deposits, detailed characterization of lithology across every location on site is not likely to be practical, except in the treatment area(s) and at any new borings or wells that are installed. Inferences by experienced geologists/hydrologists will be needed. The document provides overly generic descriptions of data gaps. The document also fails to explain how exactly the data proposed to be collected will be used to make additional decisions regarding technology selection or remedy design for this specific site. NDEP provides additional comments on Section 9 below.

   The NDEP request further definition of what is meant by "physical data." The NDEP assumes that "flow data" refers to hydraulic characteristics of areas targeted for remediation, which the NDEP agrees are needed.

   In terms of contaminant distribution data for groundwater, the NDEP notes that the **lateral boundaries of the PCE plume are well delineated to the west, north and south of the plume**, at least as far east as Spencer St. PCE was not detected (or generally detected at < 5 micrograms per liter (µg/L) in wells MW-7, MW-8, MW-9, MW-10, MW-11, MW-12, MW-15, MW-16, MW-22, MW-24, MW-28, MW-29, and MW-33.

   The NDEP notes that the PCE plume in groundwater needs to be delineated <u>downgradient</u>, all the way to the 5 µg/L concentration boundary in the area east of Spencer St. Cite the ***Draft Work Plan for Mitigation of Indoor Air and Well Water***, which should provide a description of what actions will be taken to delineate the downgradient extent of the plume.

<u>Section 1, Introduction</u>

9. <u>Page 1, Section 1.1</u>. This section contains a bulleted list of three objectives of the CAP.

   The NDEP notes that the primary purpose of the CAP is to establish a process, schedule and criteria by which a remedy for shallow groundwater will be evaluated and selected. NDEP also notes that the overall process should not be inconsistent with the National Oil and Hazardous Substances Contingency Plan (NCP). A secondary purpose of the CAP is to propose additional data collection, analysis and reporting needed to complete remedy selection and start design. Provide specific references to the objective and schedule for the ***Draft Work Plan for Mitigation of Indoor Air and Well Water*** and how actions in that document relate to this CAP document.

10. Section 1.2, page 2. The text states that "*A golf course irrigation well is located* ***near the distal end of the PCE plume*** *at a distance of approximately 3,200 ft east of the former APTC location.*"

    The downgradient extent of the PCE has not yet been delineated. If the maximum contaminant level (MCL) of 5 µg/L is used to define the plume, the "distal end" may be well beyond the golf course. Please rephrase without the text shown here in red font, and also refer to the ***Draft Work Plan for Mitigation of Indoor Air and Well Water,*** which describes the plan for plume delineation (and indoor air testing and mitigation).

11. Page 2. Figure 4. See NDEP comment 12 in NDEP letter January 11, 2011, which asked: "*Why does Figure 4 include the area west and north of the Maryland Square PCE plume? The view should be shifted to the south and east to show the plume all the way to the golf course and Flamingo Wash (the largest nearby drainage). The left-hand third of the image can be eliminated as unnecessary, as can all of the area north of Desert Inn Road.*" Why does the same figure appear unchanged in the second draft CAP for Groundwater? What is the purpose of this figure? Please explain.

12. Section 1.2.2, page 2, Boulevard Mall. Text states that "*The Boulevard Mall opened in 1968 and is the oldest enclosed Mall in the Valley, currently housing approximately 140 commercial occupants. During expansion of the Mall circa 1993, several structures located on the east side of Maryland Parkway and downgradient of the APTC facility were demolished. A three-level parking garage is currently located on the east side of the Mall next to JC Penney. A three-level parking garage is also located on the west side of the Mall adjacent to Macys.*"

    Please rewrite to indicate that the locations of these "structures" were south of (i.e., side-gradient to) the PCE plume, and that groundwater samples from monitoring wells (MW-10, MW-11, and MW-16) in the vicinity of, or directly downgradient from, these former structures have generally yielded nondetections for PCE. The locations of these former structures, along with the nondetections for PCE in downgradient wells, clearly indicate that these former structures have no relationship to the Maryland Square PCE plume.

13. The second paragraph of the Boulevard Mall discussion states "*Subsurface investigation efforts have included the installation of several monitoring wells across the Boulevard Mall property that are currently sampled and tested for PCE on a quarterly basis. The maximum PCE concentration reported in groundwater on the Boulevard Mall property was 5,310 µg/L at MW-13 in May 2005. The geologic profile logged during monitoring well installation(s) is generally characterized as sandy silt or clayey sand extending to approximately 19 feet bgs and sandy clay from 19 to 29 feet bgs within the saturated zone. Groundwater elevations fluctuate by as much as 15 or more feet across the site, which is demonstrated in the November 2010 groundwater monitoring results, wherein the groundwater elevation at monitoring well MW-6 was 1969.01 ft above mean* ***seal*** *level (amsl) and the groundwater elevation at monitoring well MW-19 was 1953.00 ft amsl.*"

    Please **delete this paragraph in its entirety**; it is not appropriate for this section. Details of the geology and information from previous site investigations are discussed in Sections 2 and 3 of the CAP.

14. Section 1.2.2, page 3, Residential Areas. Text states that "*Residences are on City of Las Vegas water that comes primarily from Lake Mead, although some City water (approximately 10 percent) is supplied from deep groundwater wells located in the northern portion of Las Vegas.*"

    Please verify and rephrase to state that homes in the residential neighborhood (Paradise Palms) are served by the Las Vegas Valley Water District (see: http://www.lvvwd.com/about/wr.html) ; however, there are homes and acreage properties east of Eastern Avenue; some of which have, or have had, domestic wells (refer again to the ***Draft Work Plan for Mitigation of Indoor Air and Well Water)***.

15. Page 3, Section 1.2.2. Please be more specific regarding the reference, "NDEP 2007." The golf course sampled the irrigation wells and provided the analytical data to the NDEP in a letter dated May 12, 2004. The NDEP summarized these data in a letter to DCI, the parent company of the former dry cleaners, on February 27, 2007. See: http://ndep.nv.gov/pce/record/2007-02-27.pdf

16. Section 1.2.3, Previous Investigations. states that "*A series of environmental investigations have been conducted across the Site since 2000 to assess groundwater, subsurface soils, and soil vapor migration.*"

    Please rewrite to clarify that soil contamination is found only in the source area. Since the initial (historical) release was reported in November, 2000, investigations have been conducted to assess the extent of PCE contamination in the source area soils, as well as in groundwater at and downgradient of the source area. In addition, a study of PCE vapors in soil gas was conducted at Boulevard Mall and in the residential neighborhood (URS, 2007).

17. Section 1.2.3. This section concludes "*Based on a review of historical documents, data gaps that remain are identified and discussed in Section 9.0.*" Yet, it is not clear what review has been done, because there are no tables summarizing the existing data from the historical documents. This review does not mention the samples of indoor air that were collected from 97 homes and two schools; although these data are not released to the public record, Tetra Tech has access to this information per the confidentiality agreement signed on behalf of the Hermann Kishner Trust (Trust). These data can, however, be discussed in a general way, without reference to specific addresses.

Section 2, Physical Characteristics of the Study Area

18. Section 2.1. Incorrect name; it is the Nevada **Division** of Water Resources

19. Section 2.2, Site Geology, page 6. Geological terminology, a as well as other words, are misused in this section. See Comments 110, 112 – 115, and 118 in Part B of this Attachment for details.

20. Section 2.3, 4th paragraph. Text states that results from aquifer tests conducted in 1991 "***are considered*** *representative of shallow groundwater characteristics in the downtown area...*"

Are there no data more recent than 20 year-old data cited in the CAP? Characteristics of shallow groundwater likely have changed appreciably over 20 years of population growth in the Las Vegas area. Also, please specify ***why*** and ***how*** these data are considered representative. There are also data from a 1999 pumping test conducted for a U.S. Department of Energy (DOE) facility in North Las Vegas (Bechtel 2000) that may be worth reviewing.

21. Page 7, 1st paragraph: Again, improper and incorrect terminology is used to describe geological conditions and groundwater geochemistry. See Comments 110, 112 – 115, and 118 in Part B of this Attachment for details.

22. Section 2.4 Geochemistry of the Shallow Groundwater states: *Groundwater samples were collected from **eight wells** and analyzed for concentrations of major anions (i.e., nitrate, sulfate, chloride, bicarbonate alkalinity), total iron, dissolved manganese, total organic carbon, and dissolved oxygen (**URS 2005**). Results generally agree with the regional geochemical characterization provided by Leising (2004). Sulfate is the dominant anion, with lesser concentrations of bicarbonate and chloride. Nitrate generally ranges from 4.5 to 7.3 mg/L in the shallow groundwater (URS 2005), and is attributed to the heavy use of fertilizers across the Valley (Leising 2004). Total organic carbon (TOC) in shallow groundwater at the Site ranges from 1.2 to 6.0 mg/L (URS 2005).*

    Please see **Comments 6 and 18** in the NDEP's previous set of review comments (January 11, 2011) on the first attempted draft CAP for Groundwater. As noted by the NDEP "*There is a moderately large data set for inorganic constituent in groundwater, based on numerous samples collected from **12 monitoring wells**. As reported in Table 4 in the groundwater monitoring report for first quarter 2008 (URS, 2008), **data for 48 samples of groundwater** show...*" The NDEP notes that sulfate concentrations reported in URS (2008) range from 1,500 to 3,700 milligrams per liter (mg/L). The text needs revision to include accurate descriptions of available data.

23. Section 2.4, Geochemistry of the Shallow Groundwater states: "*Field parameters (pH, temperature, specific conductance, turbidity, dissolved oxygen, and oxidation-reduction potential [ORP]) are routinely measured during quarterly groundwater monitoring. Most TDS measurements from across the Site are between 2,100 and 2,700 mg/L. URS (2005) reports detectable iron ranging from 1.2 to 38 mg/L and detectable manganese ranging from 0.0053 to 0.69 mg/L; however, turbidity is highly variable and can range from non-detectable to >999 Nephlometric Turbidity Units (NTU) due to the abundance of silt and clay in the saturated zone. Elevated concentrations of metals reported during prior investigations likely reflect the amount of turbidity (i.e., sediment) in the sample. Reported ranges of the field parameters are...*"

    The NDEP notes that it would be **more useful** to report median values and perhaps a few other statistics, in addition to just the range, which may just reflect outliers. The NDEP notes that **URS (2008)** reports data that range from 900 to 4,300 mg/L for total dissolved solids (TDS), with a median of 2,400 mg/L (n=200). It is unclear why an older report with fewer data (i.e., URS 2005) is used; particularly because the NDEP has previously provided a statistical summary table of the data in a January 11, 2011 comment letter (table shown again below).

Statistical Summary of Field Parameters for 32 Monitoring Wells at Maryland Square PCE Site

	pH	Temp °C	SC mS/cm	Turbidity ntu	DO mg/L	TDS g/L	ORP mV
Arithmetic Mean	6.66	24.5	4.03	153	4.11	2.5	188
Standard Deviation	0.47	1.95	4.33	211	2.08	0.51	166
Median	6.8	24.45	3.68	37	4.12	2.4	170
Minimum	4.67	18.8	1.32	0	0.54	0.9	-321
Maximum	7.41	32.5	69.4	999	9.84	4.3	634
Count (n)	217	240	240	166	225	200	223

24. Page 8, 1st paragraph notes that: "*The relatively high concentration of sulfate in groundwater, with gypsum crystals in the subsurface soils, combined with elevated concentrations of nitrate and iron, suggest* ***it would be difficult to induce reducing conditions*** *that create the anaerobic geochemical environment needed to enhance either biodegradation or reductive dehalogenation of PCE and TCE.*"

    The NDEP agrees it would be difficult. A lack of PCE degradation reflects the condition of the plume across most (if not all) of the site, as evidenced by the (only) trace amounts of PCE degradation products, primarily trichloroethylene (TCE) and cis-1,2-dichloroethylene (DCE), which have been detected inconsistently at low concentrations in some wells.

25. Page 8, 1st paragraph continues, stating: "*However, groundwater conditions at monitoring well MW-10 consistently exhibit a negative ORP that ranges from -140 to -330 mV. Negative ORP readings have also been observed periodically in MW-9 and MW-16, indicating the presence of localized areas where reducing conditions may persist.*

    The NDEP notes that the wells listed here (MW-9, MW-10, and MW-16) contain nondetect to low concentrations of contaminants (as measured in 4th quarter 2010). The groundwater sample from well **MW-9** contained 3.7 µg/L PCE, <0.5 µg/L TCE, and <0.5 µg/L 1,2-DCE; all contaminant were nondetect (<0.5 µg/L) in **MW-10** and **MW-16**. In addition, well MW-16 lies just north of well MW-11, which contained weathered gasoline. The degradation of gasoline typically drives the oxidation-reduction potential (ORP) lower in the immediate area of the fuel. Please note that average **ORP readings are higher than 100 millivolts (mV) in all the wells that actually contain significant concentrations of PCE.**

    The NDEP also notes that, as a check of the validity of the ORP measurements, consider dissolved oxygen (DO) and pH measurements taken at the same time:

    - In general, ORP values and concentrations of DO should be positively correlated (i.e., high ORP values should correspond to high concentrations of DO; low ORP values should correspond to low concentrations of DO).
    - The maximum (saturated) solubility of oxygen at the site (about 1920 feet to 1970 feet above mean sea level [amsl]) is approximately 8 mg/L DO for waters in equilibrium with atmospheric oxygen. Groundwater can be expected to contain lesser amounts of DO; therefore any DO measurements greater than 8 mg/L are highly suspect

- At the average pH (6.8) of the Site, ORP could possibly range from about -400 to 830 mV; measurements outside this range are highly suspect
- Any pH measurements of 6.0 or less are considered highly anomalous and suspect

26. Page 8, 1st paragraph continues, stating: *Given that groundwater at several additional well locations typically exhibits relatively low ORP values, in the range of 50 to 210 mV, it may be possible to use additives such as EHC® (a controlled-release, integrated carbon and soluble iron product) to achieve remediation of targeted areas of the Site. To confirm the efficacy or viability of this treatment technology, bench-scale testing or pilot testing would be necessary.*"

    Median concentrations for important naturally occurring electron acceptors in site groundwater include 3 mg/L iron; 4.5 mg/L nitrate; 1,700 mg/L sulfate; and 3.5 mg/L DO. Full dechlorination is unlikely until these electron acceptors have been reduced. The optimal Eh range for reductive dechlorination is approximately -220 to -240 mV.

    The NDEP also notes that main problem with in situ chemical oxidation (ISCO) or in situ reduction is **effective distribution** of the injected materials. The heterogeneity of the unconsolidated alluvial deposits across the Site is less than ideal for distribution of any injectate. This needs to be acknowledged in the document and testing needs to indicate how this problem will be evaluated on a site-specific basis. As noted in a technical guidance document prepared by the Indiana Department of Environmental Management (IDEM) (2009), "*The most serious problem... is getting enough oxidant [or reductant] in contact with the contamination.*" The USEPA (2004) notes that "*Chemical oxidants may not be able to penetrate low permeability homogeneous soils or horizons in heterogeneous soils that contain the bulk of petroleum contaminant mass.*" Inhomogeneous layers are also difficult, as the injected oxidants (or reductants) will follow the most permeable layer, and little will penetrate the tighter material. Finally, the Interstate Technology and Regulatory Council (ITRC) (2005) notes that "*Typical ROIs (radius of influence) for injections range from 2.5 feet for tight clays to 25 feet in permeable saturated soils.*"

    The NDEP notes that if laboratory (bench-scale) tests fail, there is certainly no need to go to field pilot tests; however, "successful" bench-scale tests cannot predict success at the field scale.

Section 3, Nature and Extent of Contamination

27. **Section 3.1**. See Comments 110, 112 – 115, and 118 in Part B of this Attachment for details.

28. Page 9, Section 3.1, first paragraph states that "*The investigation of groundwater began in August 2000. Additional wells have been installed several times since 2000 to evaluate the extent of dissolved PCE in groundwater. Regularly scheduled monitoring of groundwater has been conducted since May 2005. Currently, 33 monitoring wells are installed at the Site, 31 of which are part of the monitoring program (Figure 3). Eleven wells in the residential area of the plume are monitored quarterly. Eleven wells in the area of the former APTC facility, the Boulevard Mall, and the southwestern residential area are monitored semi-annually. All 33 wells in the program are monitored during the 4th quarter monitoring event.*"

As written, this states that each additional well has been installed several times. To convey the correct meaning, the text should state, "Since discovery of PCE-contaminated groundwater at the site of the former dry cleaner, additional wells have been installed across the site to evaluate the extent...."

The number of wells is incorrect; 32 wells (i.e., all 33 except MW-4) are part of the monitoring program. The NDEP has requested several times, that well **MW-11 be sampled annually**.

29. Page 9, Section 3.1, second paragraph states that "*The PCE plume extends approximately 4,000 ft east from the APTC source to the east side of the National Golf Course (Figure 3).*" Actually, the length of the plume, if defined by the 5 µg/L contour, may well extend beyond 4,000 ft from the source area. Suggest rewriting to state that "the plume is at least 4,000 feet in length, but has not been fully delineated to the east at the 5 µg/L contour." Reference the ***Draft Work Plan for Mitigation of Indoor Air and Well Water***, which provides the plan for downgradient delineation of the PCE plume.

30. Page 9, Section 3.1, second paragraph states that "*The plume extends due east from the source, under the Boulevard Mall, then slightly curves to the north under the neighborhood between Cherokee Lane and Seneca Lane toward irrigation well PW-1, located within the Las Vegas National Golf Course. The plume east of PW-1 is estimated to extend 1200 ft. The center line of the plume is estimated to extend through MW-6, between MW-19 and MW-20, just north of MW-23 and MW-25, and approximately midway between MW-26 and MW-32 toward PW-1. PCE concentrations in the shallow groundwater along the centerline are estimated to be 2,500 to 3,000 µg/L near the Boulevard Mall, 1,500 to 2,000 µg/L near MW-18 and MW-23, and approximately 1,000 µg/L between MW-26 and MW-32.*"

The NDEP notes that this description of the plume geometry is described incorrect in the CAP, possibly biased by the fact that **the golf course irrigation well is incorrectly located** (Figure 3 in CAP). As noted in the NDEP's comments on the first draft CAP for Groundwater, irrigation well PW-1 is located approximately 250 feet **due east** of monitoring well MW-27.

The NDEP notes that the plume shows no "curve to the north." but rather, shows a slight widening to the north along Spencer when the groundwater plume encounters a shallower gradient in the area of the golf course (potentially due to a slight mounding resulting from irrigation of the golf course). If one looks at recent (2008 – 2010) averages of concentrations for each monitoring well, it is clear that the plume centerline runs almost directly down Seneca Lane. Therefore, from the source to the east side of the golf course, the plume trajectory appears to be about 1 or 2 degrees north of due east.

Please describe what analysis was made to obtain the estimate of "1200 feet east of PW-1" as the extent of the plume.

31. Page 9, Section 3.1, paragraph 3 states that "*Assuming a gradient of 0.013 ft/foot (Tetra Tech 2010a), an assumed average hydraulic conductivity of 15 ft/day (based on reported values provided in Section 2.3), and a porosity of 0.30, an annual, average groundwater flow rate of 237 ft/year for the shallow groundwater is derived. If the plume moved 100 to 130 ft/year, the PCE is attenuated at a factor of 1.8 to 2.4, which is within the expected range for PCE migration in a low degradation environment.*"

Why not use the Bioplume or Biochlor model to demonstrate this and provide graphic output? Also, explain more clearly how the 100 to 130 ft/year movement of the plume was determined (i.e., by the leading edge of dissolved phase PCE at 5 ug/l [which has not been defined for the site] or other means).

32. Page 9, Section 3.1, fourth paragraph states that "*The plume migration initially would have been through the mixtures of fine sands and gravels as a preferential flowpath because of the higher hydraulic conductivity. The dissolved PCE then would have migrated into the silts and clays by diffusion and along soil partings (secondary porosity from differential stress cracks and desiccation partings that do not reseal due to the calcic water that minimizes clay swelling). Therefore, preferential flow paths likely allowed the leading edge of the plume to migrate 100 to 130 ft/year, while movement into and through the clay and silt units likely occurred at 1 to 20 ft/year. The plume at the Site is expected to be stable at its lateral extent, with remnants of later releases (such as periodic flushing/cleanout of the sump and drain lines) likely still moving through the plume as slugs (mobile hot spots of higher PCE concentration).*"

It seems that the writer is attempting to describe groundwater flow through preferential pathways in lithologically heterogeneous alluvial deposits. Please note that models using a **dual-domain** mass transfer approach for solute transport in heterogeneous aquifers may be applicable at this site (see, for example: Feehley et al 2000). Discuss contaminant migration in this context.

Again, incorrect terminology is used to describe the geology, geochemistry, and hydrogeology. See Comments 110, 112 – 115, and 118 in Part B of this Attachment for details.

What is the derivation for the concept of "**mobile hot spots**" of dissolved PCE migrating as slugs? "Hot spot" is typically used informally to describe areas of exceptionally high concentrations of contaminants in soil. The NDEP is unfamiliar with usage of "**mobile hot spot**" to describe groundwater contamination. The hypothesis espoused here, of "slugs" of PCE released suddenly to groundwater and now moving as "mobile hot spots" seems contrived. What evidence or literature support can be provided to support this concept?

33. Pages 9 and 10, the last/first paragraph states that "*The PCE concentrations in the groundwater have fluctuated over time, with many wells exhibiting apparent decreases (Figure 12). In the upgradient portion of the plume, changes likely are due to movement of PCE slugs. For example, the concentration of dissolved PCE in MW-1 varied between 870 and 3,500 µg/L during 2000 to 2005, but decreased to below 1,000 µg/L by June 2007. The concentration of PCE in groundwater in MW-2 was at 3,000 µg/L in 2000 to 2002, and decreased to below 1,000 µg/L by June 2008. PCE concentrations in MW-6 decreased in late 2005, then increased over the next 4 years and are currently near 2,500 µg/L. The groundwater in MW-13 had the highest PCE concentration ever reported (5,310 µg/L) in May 2005; since that time, the PCE concentrations have decreased to below 3,000 in 2007, and below 2,000 in 2010. MW-14 and MW-18 previously also had groundwater with PCE above 3,000 µg/L. PCE concentrations in groundwater at MW-14 were below 1,000 µg/L as of 2007, and in MW-18 have been below 2,000 µg/L since December 2006. PCE concentrations in groundwater in MW-23 have been below 2,000 µg/L since June 2007. PCE concentrations in wells MW-19, MW-20, MW-23, MW-25, MW-*

26, and MW-32 have all decreased to below 1000 μg/L. In the downgradient area of the plume, these decreases are likely due to lateral spreading of the plume by diffusion into the finer grained silts and clays".

Please rewrite this paragraph, with data summarized in tables or on readable graphs. Use statistical trend tests to evaluate trends in concentration at each well, if trends are discussed. Analytical data and statistical test results should be summarized in a table for discussion.
The NDEP notes that the graph shown as **Figure 12b** (there is no 12 or 12a) shows data from all 33 site wells and is difficult to read. Breaking the data into logical subgroups (e.g., source area wells, west mall wells, east mall wells, etc.) could provide useful information on the behavior of the PCE plume.

Results of **duplicate samples** collected during fourth quarter of 2010 suggest that there is potentially significant vertical heterogeneity in contaminant distribution. The "apparent decreases" may reflect minor changes in the sampling protocols used and the depth from which samples were collected. **Duplicate samples for MW-19, MW-26, and MW-30** show relative percent differences of **15.5%, 11.3%, and 12.2%.** Vertical distribution of contaminant concentrations in groundwater (and the need to evaluate such distribution) is not discussed in the CAP, but should be.

$$\%RPD_i = \left(\frac{2 \times |O_i - D_i|}{(O_i + D_i)} \right) \times 100$$

34. Page 10, Section 3.2, last sentence states that "*Of the 32 samples that contained detectable concentrations of PCE, significant amounts of the tracer gas were found in four samples, indicating leakage from the atmosphere and invalidating the results.*"

    Please add to the end of this sentence ***"for these four samples."***

35. The first paragraph of Section 3.3 states that "*The NDEP conducted neighborhood sampling events between fall 2007 and winter 2007-2008. During these events, 97 homes and two schools were sampled for PCE and related compounds in indoor air. Of the homes sampled, 15 homes exhibited PCE concentrations greater than the NDEP indoor air interim action level of 32 μg/m3 (Broadbent & Associates [Broadbent] 2010).*"

    As written, the period of sampling is unclear. Please rewrite to indicate that, "*between September 2007 through March 2008, the NDEP collected indoor air samples from 97 homes and two schools (Broadbent & Associates [BAI] 2008). Samples were collected in 6L Summa canisters over a 24-sampling period, then shipped to the laboratory for analysis of PCE, TCE, and vinyl chloride using USEPA Analytical Method TO-15 GC/MS. Samples from fifteen of the homes contained concentrations of PCE that exceeded the NDEP's interim action level of 32 μg/m3 for PCE in residential indoor air (BAI 2010).*"

    Also, please specify that the data for indoor air samples and the BAI reports are being kept confidential, in order to respect the privacy of the homeowners. These data are released to attorneys (and their consultants) upon signing of a confidentiality agreement.

Section 4, Contaminant Fate and Transport

36. Section 4, first paragraph notes that "*PCE may have migrated east of Maryland Parkway via the sewer line, with releases potentially occurring from leaks at the connection to city sewer lines.*"

    The NDEP notes that soil beneath the sewer-line junction of the lateral from the former dry cleaners and the main line underlying Maryland Parkway has never been sampled. However, releases at this junction could lead to high concentrations immediately east of Maryland Parkway, such as seen in well MW-6.

37. Section 4, third paragraph states that "*The lateral spread may have been due to the influence of the **utility lines** along the South Maryland Parkway.*"

    The NDEP notes that the depth to groundwater in this area is about 18 ft below ground surface (bgs), whereas utility lines are typically 8 ft bgs or less. It therefore seems unlikely that utility lines would have had much, if any, influence on the lateral migration of PCE. If "utility lines" is used here to mean "sewer lines," then the latter should be used instead, and the next paragraph applies.

    If "utility lines" refers to sewer lines, then yes, the intersection of the sewer lateral from the dry cleaners to the sewer main could be a point of additional leakage. The width of the plume at this point is approximately 400 to 500 feet. The sewer flows north up S. Maryland Pkwy, then east on Desert Inn Rd. Once in the main sewer line, the PCE does not appear to have leaked to the north of the lateral junction with the main sewer, because there is a lack of detectable PCE in wells a short distance north of the plume (see data for MW-15 and the "Gap" well for Boulevard Mall). Also, there would have been no flow to the south in the sewer main, yet the plume appears to be symmetrical north and south of the source location, and. Therefore, the data do not appear to support the suggestion that "*The lateral spread may have been due to the influence of the **utility lines** along the South Maryland Parkway.*

    If "utility lines" refers to the storm drain line, this line flows south toward Flamingo Wash. However, the same comments about plume symmetry apply.

38. Page 11, fourth paragraph states that additional wells "*...established the extent of the plume to the east side of the National Golf Course, an approximate distance of 4,000 ft from the source area.*"

    Please note that the downgradient extent of the plume is **not yet defined to the 5 µg/L** contour. Please restate and also refer to the ***Draft Work Plan for Mitigation of Indoor Air and Well Water*** (which provides a plan for delineation) and the NDEP's comments on this work plan.

39. Page 11, fourth paragraph states that "*The plume at the Site is assumed to be stable at its eastern extent.*"

    Any such statement regarding plume stability should be tested, not assumed. Please apply a statistical trend test to evaluate stability at confidence levels of 80% and 90%.

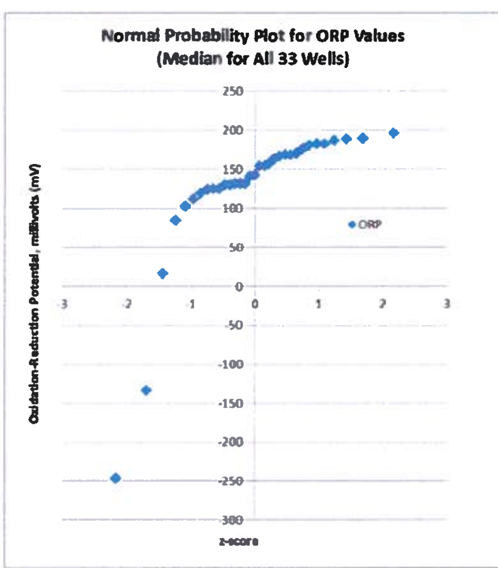
40. <u>Page 11, fourth paragraph</u> states that "*Slugs with higher concentration of PCE from releases in the late 1990s (such as from flushing /cleanout of the sump and drain lines) are likely still moving through the central area of the plume.*"

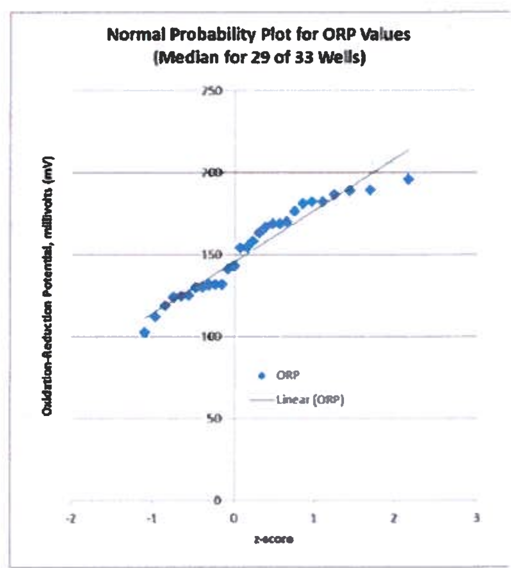
The CAP presents no data, evidence, or evaluation to support the statement that "slugs" of PCE were released in the "late 1990s." What is the basis of this statement? Any releases on the ground surface, from floor drains, or from sewers, would still need to migrate down through the soil until reaching groundwater (about 20 ft bgs). Movement through the soil column would be attenuated, so it is difficult to reconcile this with PCE released as "slugs" to the groundwater. Please provide evidence, data, or literature references supporting this suggestion. A better explanation for the apparent distribution of PCE in the shallow groundwater is that the heterogeneity of the interbedded clay, silt, sand and gravel deposits controls a vertically and horizontally complex plume distribution. The existing monitoring well network may not be capable of completely defining internal PCE distribution at the actual scale of the 500 µg/l and 1,000 µg/l PCE isoconcentration contours across the Site. It will be important to better define vertical plume distribution and hydrogeologic characteristics and connectivity in the areas proposed for the shallow groundwater remedy.

41. The NDEP notes, again, that the golf course irrigation well, PW-1, is incorrectly located on Figure 3.

42. <u>Page 12, fifth paragraph</u> states that "*The site chemistry is strongly aerobic across most of the site, although there may be **pockets of anaerobic zones**, as exemplified by conditions near well MW-10 that exhibits a negative ORP range of -140 to -330 mV.*"

It is true that **MW-10** has shown low ORP; however, this well also shows <u>low to nondetect</u> levels of PCE. The NDEP notes that there are only two wells that have average ORP values less than 0 mV; MW-10 and MW-11, and only two other wells (MW-9 and MW-16) with ORP median values less than 100 mV. **Three of these four wells <u>never contained</u> significant concentrations of PCE**, and MW-9 was screened deeper as an "intermediate well".





The lack of reducing conditions (i.e, median ORP values >100 mV) in the other 29 of the 33 wells suggests that **the four wells with lower median values for ORP are atypical for the Site**. The median values for each well plotted on normal probability plots (see below) support this observation, showing a marked inflection point between the line defining the low ORP wells and the rest of the site wells. The NDEP notes that the optimal ORP for complete reductive dechlorination is -220 to -240 mV.

43. Page 12, fifth paragraph continues, stating that "*Biodegradation Biodegradation of PCE occurs under anaerobic conditions through the bioactivity. URS (2005) submitted two groundwater samples to ascertain the population of DHC bacteria; however, the presence of DHC bacteria was not evident. Aerobic conditions inhibit the growth of DHC bacteria. In addition, as sulfate is present in the groundwater at relatively high concentrations, artificially inducing reducing conditions will produce high concentrations of sulfide that will also inhibit DHC bacteria. Therefore, inducing reducing conditions by injecting only electron donors (such as HRC®) is not likely to be effective. However, electron donors combined with zero-valent iron (ZVI)* ***have had some success in high sulfate groundwater****. This suggests that induced reductive dehalogenation using a product such as EHC® may be possible. This may be cost-effective in areas where the ORP is no higher than 200 mV. Bench-scale and pilot-scale testing would be necessary to evaluate the feasibility of this treatment option.*

Please provide references for the statement that "*electron donors combined with zero-valent iron (ZVI)* ***have had some success in high sulfate groundwater.***" If the only reference is from tests performed by the vendor, then this is considered experimental and not representative of actual successful application. **Calculations should be conducted before any testing**; using the maximum and median concentrations of electron acceptors in the shallow groundwater system. Median values include 3.5 mg/L DO, 5.9 mg/L nitrate, 1700 mg/L sulfate, 220 mg/L alkalinity, along with concentrations of iron and manganese.

Also, the NDEP notes that **partial degradation of PCE is unacceptable**, because TCE, 1,2-DCE and vinyl chloride also pose vapor intrusion concerns

Section 5, Human Health Risk Assessment

44. **Section 5 of the draft CAP is unacceptable**. Existing data should be used to conduct a human health risk assessment (HHRA). Existing data have laboratory quality control (QC) data to allow for a Level IV validation.

A proper evaluation of the existing data, along with a listing of the data needed, should have been conducted to identify data gaps. The draft CAP fails to provide any of these.

45. Section 5, page 13 states that "*It is anticipated that the results of a baseline risk assessment predicting and quantifying potential risk from indoor air exposure, as well as other potentially complete exposure pathways, will be presented in the final CAP after adequate data are obtained.*"

As the NDEP has previously stated (see **Comment 2**, below, from **NDEP letter dated January 11, 2011**), there are data already available for indoor air samples collected from 97 homes. The CAP gives no reason why these data cannot be used to perform a HHRA now. This HHRA can be updated periodically, as new data are collected.

"There are analytical data for samples of groundwater, soil, soil gas, and indoor air for the Site. It is unclear why these data are deemed "insufficient" in terms of quantity and quality, or what would be defined as "sufficient." The NDEP notes that the issue is data usability, and it appears that the available analytical data have not been reviewed to assist in preparation of the CAP, let alone assessed for usability. Please review the laboratory results and quality control (QC) data for usability (see U.S. Environmental Protection Agency [USEPA] 540-R-08-01, 2008). ***Unless data are rejected, they are usable****. Please specify explicitly."* (NDEP letter, January 11, 2011).

Section 6, Identification of Preliminary Corrective Action Objectives and Remediation Standards

46. Section 6, page 15, first complete paragraph states that "*...concentrations lower than the PQL cannot be reliably measured. The laboratory PQL for PCE in water is 0.5 μg/L. The laboratory PQL for PCE in indoor air varies by laboratory and analytical method but is generally less than 10 μg/m3. NDEP's indoor air sampling program achieved an average detection limit for PCE in indoor air of 5.6 μg/m3 (NDEP 2011). Laboratory PQLs are not low enough to detect PCE concentrations in indoor air of 0.32 μg/m3.*

    The NDEP used Method TO-15 because **the detection limit was sufficient for the purpose of the testing** (method detection limit [MDL] ~ 3.4 micrograms per cubic meter [μg/m3] for PCE). The purpose of NDEP's testing was to evaluate whether any homes contained PCE vapors at concentrations exceeding the NDEP's interim-action level of 32 μg/m3. However, Method TO-15 SIM is capable of much lower detection limits. Air Toxics Laboratories using selective ion mode (SIM) achieves detection limits of less than 1 μg/m3 (see study for the Maryland Department of the Environment [DEP], 2007): http://www.mde.state.md.us/assets/document/Glenn%20Heights%20ASI%20Report%20-%20Final.pdf

    The appropriate analytical method must be used to achieve detection limits that are **less than the remediation standard** selected for residential indoor air. For example, if a remediation standard of 3.2 μg/m3 were to be selected (10^{-5} risk level), TO-15 SIM would be needed, rather than TO-15. Please also reference the ***Draft Work Plan for Mitigation of Indoor Air and Well Water***.

47. Section 6, page 15, first complete paragraph states that "*The numbers generated in the previous three steps for PCE in indoor air were NDEP's interim action level (a risk-based concentration of 32 μg/m3 associated with a risk factor of 10^{-4}), a risk-based concentration correlating to the 10^{-6} risk level (0.32 μg/m3), and the laboratory PQL.*"

    As noted in the NDEP's comment above, the reporting limit for TO-15 SIM is generally less than 1 μg/m3. The Maryland study cited above shows laboratory analytical reports, with reporting limits of 0.16 to 0.36 μg/m3 for PCE, and 0.13 to 0.14 μg/m3 for TCE. The numbers discussed for the laboratory reporting limits should include a summary of such limits for the different analytical methods, so that the appropriate method is selected to provide the data necessary to address the specific needs of the study.

Moreover, the MDL is defined the USEPA in 40 CFR part 136, Appendix B (49 FR 43234 dated October 26, 1984), as *"the lowest concentration that can be measured and reported with 99% confidence that the concentration is greater than zero."* The sample quantitation limit (SQL) is the sample-specific MDL, which takes into account the specifics of the sample and sample analysis (e.g., matrix, dilution, etc.) Although the precision (i.e., reproducibility) of measured concentrations near the MDL may be poor, all such "estimated" data should be used "as is" in any statistical analysis of the data.

Section 7, Identification of Screening Technologies

48. Page 16, first paragraph states that "*In general, the same or similar GRAs, remedial technologies, and process options are applicable in the source area, Boulevard Mall, and residential areas...*"

    The NDEP does not necessarily agree that the same options are applicable to the residential neighborhood, as in the commercially zoned areas. Safety issues, noise, and property access, among other factors, limit options in the residential neighborhood.

49. Page 16, last paragraph states that "*This section analyzes the technology types and process options for each GRA in terms of three broad screening evaluation criteria: **effectiveness, implementability, and cost** (EPA 1988). Potentially applicable GRAs identified for groundwater consist of (1) No Action, (2) ICs, (3) engineering controls, (4) MNA, (5) treatment, and (6) containment. Process options for containment were not retained after the initial screening based on difficulty of implementation and ineffectiveness. The five remaining GRAs are discussed in this section. Given the concentrations of PCE in groundwater at the Site, the subsurface conditions, and the **various receptor pathways,** it is likely that an integrated approach to remediation or a combination of general response actions will be required.*"

    The NDEP notes that hydraulic containment (extraction wells) with pulsed pumping, above-ground treatment and reinjection (to reduce zones of stagnation) combines containment and remediation. In contrast, a slurry wall alone would be classified as containment.

    Please list "*the **various receptor pathways***" being referred to here.

    Page 17, fourth paragraph states that "*ICs may mitigate unauthorized use and exposure to shallow groundwater by virtue of education and awareness; however, **unauthorized or unlawful uses** of groundwater cannot be reasonably precluded through ICs or other administrative or engineering controls.*"

    Please review and cite the relevant water regulations governing water use.

50. Page 17, last paragraph states that "*Because (1) the location and status of unauthorized groundwater wells is unclear and (2) shallow groundwater is not a designated source of drinking water, **engineering controls** (e.g. individual wellhead treatment units) **addressing individual unauthorized groundwater wells were not considered.***"

    See previous comment. Also, the NDEP notes that domestic water supply wells are to be addressed in the ***Draft Work Plan for Mitigation of Indoor Air and Well Water*** (document dated February 28, 2011). Refer the reader to this work plan.

51. **<u>MNA.</u>** <u>Page 20, second paragraph</u> states that *"abiotic MNA may further reduce the concentrations of contaminants to complete the attainment of corrective action goals. Therefore, MNA was retained as part of a groundwater treatment train..."*

Please note that the data suggest attenuation by sorption and dispersion only; there does <u>not</u> appear to be degradation of the PCE, even after the estimated time of 40 years and 4,000+ ft of plume migration.

52. **<u>In Situ Chemical Oxidation.</u>** <u>Page 20, fourth paragraph</u> states that *"Chemical oxidation is implementable; however, success implementing the technology depends on site geology because it influences the ability to distribute the oxidant within the treatment zone.... Chemical oxidation has been shown to destroy PCE and its breakdown products both in the laboratory and in the field."*

The NDEP notes that distribution of the oxidant throughout the contaminated area may be the <u>main challenge</u> for this alternative. Flow through the heterogeneous lithology of the alluvial deposits is likely best described as **"dual-domain" flow** (Gillham et al, 1984). Even if the oxidant successfully destroys the solvent in the coarser grained materials, contaminated fine-grained materials may remain unremediated, and act as a secondary (long-term) source. This remedy (as well as many other possible remedies) needs to be discussed in the context of **dual-domain flow**.

Please provide references of successful application of ISCO under similar conditions and for a plume of the magnitude of the Maryland Square PCE plume.

53. **<u>In Situ Chemical Oxidation.</u>** <u>Page 20, last paragraph</u> states that *"In addition, careful planning and control is needed when injecting near residences or underground utilities that could provide preferential pathways; however, given that the depth to groundwater in most cases is below 17 ft bgs, preferential pathways via utility corridors are not likely. A contingency plan to detail precautions that would be taken to ensure the safe application of chemical oxidant at the Site is warranted."*

The NDEP notes that groundwater has been measured at less than 9 feet bgs in the western part of the residential neighborhood. (MW-18, May 2005). Potential safety issueswill need to be addressed as part of obtaining a permit from the NDEP for injections of high concentrations of oxidizing chemicals within the residential neighborhood, because there is no certain way to control the migration of these chemicals.

It is not possible to guarantee that the oxidants, or the oxidation byproducts, would behave the same as the PCE plume, or migrate along the same pathways.

Each oxidant type has specific drawbacks such as potential permeability issues associated with MnO_2 precipitation with permanganate, or potential volatilization from the exothermic reactions associated with either persulfate or Fenton's reagent, any of which can create safety concerns.

Please provide references of successful application of ISCO under similar conditions and for a plume of the magnitude of the Maryland Square PCE plume.

54. **<u>In Situ Chemical Reduction.</u>** <u>Page 21, second paragraph</u> states that "*Although* ***in situ chemical reduction*** *can effectively treat PCE; the costs are expected to be moderate to high. Chemical reduction is implementable; however, success implementing the technology depends on site geology because it influences the* ***ability to distribute the chemical within the treatment zone****. Elevated sulfate concentrations in groundwater may influence the cost and performance of this technology. While* ***some have suggested*** *that ZVI can directly reduce sulfate to sulfide, it is more commonly noted that reduction of sulfate is biologically mediated (Environmental Technologies, Inc. [ETI] 2007)*."

It is the abundance of electron acceptors, not just the high concentration of sulfate (as much as 3,700 mg/L), that needs to be considered. Please provide references for sites where sulfate reduction to sulfide in a permeable reactive barrier (PRB) has been observed and described.

The NDEP notes that distribution of the reductant throughout the contaminated area is also a challenge for this alternative. Even if the reductant successfully destroys the solvent in the coarser grained materials, contaminated fine-grained materials may remain unremediated, and act as a secondary (long-term) source. This remedy also needs to be discussed in the context of **dual-domain flow and mass transfer.**

The elevated concentrations of sulfate (average 1,700 mg/L, maximum 3,700 mg/L) present at the site are problematic for achieving complete dechlorination. Sulfate reduction (Eh about -220 mV to -240 mV) would be required to get the PCE to fully dechlorinate to ethene, during reductive dechlorination. Moreover, sulfate reduction produces sulfide, which is toxic to the dechlorinating bacteria. Elevated sulfate/sulfide could result in partial dechlorination of PCE, resulting in a "stall" of the process and the buildup of TCE, cis-1,2-DCE and/or vinyl chloride. Vapor intrusion risks exist for all of these daughter products.

55. **<u>In Situ Chemical Reduction.</u>** <u>Page 21, second paragraph</u> states that "*However,* ***elevated concentrations of dissolved sulfate do not automatically disqualify ZVI as a potential treatment option****. <u>Studies have shown</u> that ZVI can still effectively treat chlorinated ethenes such as PCE in the presence of elevated sulfate concentrations. ETI has performed column tests on groundwater from various sites containing up to 6,000 mg/L of sulfate with little or no interference from sulfate* ***(ETI 2007)****.*"

Please provide references of successful application of reductant under similar geochemical and geological conditions, and for a plume of the magnitude of the Maryland Square PCE plume. The NDEP was unable to locate the ETI (2007) report referenced here.

56. **<u>In Situ Chemical Reduction.</u>** <u>Page 21, third paragraph</u> states that "t*he effects of sulfate and electron acceptor concentrations on cost*" will need to be evaluated.

Calculations and a rough estimate of the amount of zero-valent iron (ZVI) should have been presented in the CAP. Based on some assumptions and a sulfate concentration of 3,000 mg/L, the NDEP used the Regenesis on-line calculator and calculated that approximately 1 million pounds of HRC-X would be needed to reduce sulfate and other electron acceptors at the site. That equates to about $8.7 million worth of HRC-X.

57. **Sparging.** Page 21 states that "*Sparging technologies may be applicable in source areas, areas of higher PCE concentrations, or as a curtain east of the Boulevard Mall to intersect and treat the plume before it flows under the residential neighborhood. Pilot tests should be conducted to determine the effectiveness of sparging, ozone treatment, and/or SVE and associated ROIs.*"

    Designing an in-situ sparging system would require that the vertical and cross-sectional profile of the PCE plume be well defined for optimum placement of the sparge points. Pilot testing would need to be conducted to determine the effective radius of influence of a sparge point and to define the initial and design operational parameters (i.e., number of sparge points, operating pressures and flow rates, etc.). The NDEP agrees that soil-gas-permeability testing should be performed to design an SVE system that will capture the vapors created by the sparging action.

58. **Permeable Reactive Barrier.** Page 22 states that "*Subsurface geology can influence the performance and longevity of PRBs. If carbonate or other solid phase precipitates form within the PRB, hydraulic conductivity and reactivity (treatment efficiency) may diminish. Bench-scale treatability testing would be necessary to evaluate the likelihood of precipitate formation, and pilot testing should be conducted to help evaluate installation procedures and determine how the PRB would perform at the site.*"

    The ZVI-based PRB technology is susceptible to premature passivation (i.e., loss of its catalytic properties) by high alkalinity, TDS, and sulfate. The groundwater at the Maryland Square site has been characterized with an alkalinity near 300 mg/L, TDS levels ranging from 900 to 4,300 mg/L, and sulfate concentrations averaging 1,700 mg/L, with a maximum measured at 3,700 mg/L range (URS 2007, see Tables 2 and 4). These concentrations are in the ranges where these constituents are known to impact the longevity of ZVI-based PRBs due to mineral precipitation and/or other surface coating reactions (ITRC, 2005).

    Sulfate has the potential to enhance the growth of sulfate-reducing bacteria that feed off of the hydrogen released during iron corrosion. Excessive growth of sulfate reducers can cause biofouling, which in turn can cause preferential flow through the barrier and reduce the hydraulic residence time. Depending on the severity of clogging problems, groundwater flow may eventually bypass the PRB all together.

    Please provide examples of sites with similar geochemistry and geology that have had success with a PRB applied to a solvent plume of similar magnitude.

59. **Enhanced Bioremediation.** Page 22 states that "*DHC bacteria have not been found at the Site; therefore, bioaugmentation would likely be required. The absence of DHC is likely due to the predominantly aerobic conditions in the aquifer. However, given that the ORP of groundwater in many of the wells is generally in the range of 50 to 210 mV, it* ***should be*** *cost effective to artificially create reducing conditions. In addition, because sulfate is present in the groundwater at high concentrations, sulfate reducing bacteria will produce high concentrations of sulfide, which might inhibit DHC. Therefore, biostimulation through injection of electron donors alone is not likely to be effective. This is evident in the poor performance of HRC® that has been used as a biostimulant at sites in the Las Vegas area (NDEP 2009). However,* ***electron donors combined with ferrous gluconate have had some success in high sulfate groundwater.*** *This may be because dissolved sulfide concentrations are reduced*

through reaction with dissolved iron. This suggests that reductive dechlorination using iron containing product such as EHC® or an alternate electron donor combined with ferrous gluconate might be possible. Should an integrated remedial approach involve the use of enhanced bioremediation, bench-scale testing is required to determine the most effective form of enhancement and/or augmentation."

PCE degrades under anaerobic conditions, which would require creating reducing conditions (-220 to -240 mV is the optimal range for reductive dechlorination) in the aquifer and maintaining the conditions where dechlorinating microorganisms could survive. It is most likely that an exogenous culture would be required to avoid long lag periods before such microbial populations developed to the level required to reductively dechlorinate the PCE. Because of the geochemical conditions, a significant amount of reductant would be required to reduce the aquifer, the flux of oxygenated groundwater into the reduced zone would rapidly deplete the "stored" reducing power, and (as noted in the CAP) the sulfate could cause issues with sulfide generation. Calculations ***should be*** performed to estimate the amount (and cost) of the reagent necessary to artificially create a reducing environment, ***before*** conducting bench-scale tests.

Bioreactors would have to deal with the sulfide toxicity issue, as well as the potential for offensive odors. Techniques to overcome the sulfide toxicity issues through the addition of ferrous or mineral forms of iron are would add costs to the project. Biological approaches for treating PCE in groundwater may not result in complete treatment, thereby creating the potential for vapor intrusion of chlorinated daughter products.

Please provide references documenting success, re: the statement that *"electron donors combined with ferrous gluconate **have had some success in high sulfate groundwater.**"*

60. **Extraction and Treatment.** Page 23, second paragraph
Again, improper and incorrect terminology is used to describe geological conditions and groundwater geochemistry. See Comments 110, 112 – 115, and 118 in Part B of this Attachment for details.

61. **Extraction and Treatment.** Page 23, third paragraph states that *"Soil samples collected from the Site indicate the sand **intervals frequently** contain appreciable silt or clay (as much as 30 to 40%). Hydraulic tests at the site and in nearby areas of the City of Las Vegas indicate hydraulic conductivities likely range from 0.8 to 20 ft/day or 6 to 150 gpd/ft2. Assuming saturated intervals of 25 ft and 20 ft of available drawdown, the yields of individual wells may range from 1 to 20 gpm, with sandy zones at the higher rates and silts at the lower rates. However, considering the numerous hydraulic barriers and limited unit thicknesses created by the heterogeneous conditions, and superposition effects from the influence of adjacent extraction wells, steady state production rates can be expected to be significantly lower-in the range of 0.2 to 8 gpm. The sand zones will likely be depleted relatively quickly, with the capture zone of the well field likely being dewatered. The use of **injection wells to return treated water to the groundwater system** can help minimize the potential negative effects of a remedial production well field. Although greater production rates can be achieved by installing the wells to depths of 50 to 60 ft bgs in the Las Vegas Wash Aquitard, such well construction may only lead to greater dewatering of the shallow groundwater system. The well system would likely operate intermittently. Saturated clays at the Site **would likely dewater and may shrink**, potentially **resulting in subsidence** in the residential and Boulevard Mall areas.*

See Comments 110, 112 – 115, and 118 in Part B of this Attachment for more details.

The specter of subsidence as a result of groundwater extraction at this site seems inappropriate. Please provide references documenting (1) the presence of dominantly 2:1 clays in the geologic deposits at the site, (2) other sites, with similar geologic deposits, similar proposed rates of extraction, and similar infrastructure, where subsidence has been documented. The NDEP notes that subsidence as a result of groundwater pumping is documented in cases of water-supply wells mining groundwater over a long period of time. The NDEP is not familiar with any documented case of subsidence resulting from a pump and treat system used for site remediation.

Again, dual-domain flow should be part of the discussion here.

62. **Extraction and Treatment.** Page 23, paragraph 4 states that "*Production tests should be conducted within several silt, sand and gravel units at the Site to evaluate whether pump and treat is a viable alternative for remediation of groundwater at the Site. Current data indicate that Site conditions are not conducive to this option as the primary remedial approach.*

The unconsolidated geologic deposits at the site generally range from silty clay to silty sands, with some layers and lenses of silty/sandy gravel. Based on this knowledge, the hydraulic conductivities that may generally be expected at the site would range from 10^{-6} to 10^{-3} centimeters per second (cm/sec) or 0.0028 to 2.8 ft/day. A detailed profiling of the lithology and the vertical distribution of PCE concentrations at the treatment area(s) would be needed.

63. **Extraction and Treatment.** Page 23, paragraph 5 states that "*Furthermore, treatment by air stripping or GAC will generate a secondary waste stream, and high TDS concentrations in the treated wastewater discharge may present complications due to water quality standards and policies imposed by the Colorado River Basin Salinity Forum. If TDS must be removed from treated water before surface discharge, disposal, or* ***reinjection****, costs will be high. Despite these practical constraints,* ***extraction and treatment may be effective as a hydraulic control;*** *therefore, the technology was retained for further consideration.*

The NDEP notes that, as long as the treated water is reinjected back into the plume and degradation is not an issue (i.e., no further degradation), then this is allowed under UIC regulations and a permit may be issued. The NDEP views capture/containment of the mass of dissolved-phase PCE that lies upgradient of the neighborhood, treatment, and reinjection downgradient of the point of extraction as a viable option.

Section 8, Development and Detailed Analysis of Alternatives

64. The introductory text in this section states that "*The alternatives were developed and screened based on the requirements of NAC 445A.2271; guidance issued and offered by NDEP; and in a manner consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA); the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); and Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA 1988)*

The following groundwater alternatives were developed for analysis in this CAP:
Alternative 1 *– No Action*
Alternative 2A *– In Situ Chemical Treatment of Hotspots and Residential Area, ICs, SSD Systems, and MNA*
Alternative 2B *– In Situ Chemical Treatment, ICs, SSD Systems, and MNA*
Alternative 3 *– Permeable Reactive Barrier, ICs, SSD Systems, and MNA*
Alternative 4 *– Sparge Curtain, ICs, SSD Systems, and MNA*
Alternative 5 *– Extraction and Treatment, ICs, SSD Systems, and MNA*
Alternative 6 *– In Situ Enhanced Bioremediation, ICs, SSD Systems, and MNA.*

The NDEP notes that the **data needs for each alternative should have been provided**, along with an analysis of the existing data. This would have allowed identification of data gaps. This type of analysis is missing from the CAP.

65. Page 27, NDEP Acceptance states that "*NDEP has indicated its concern with the viability of in situ reductive treatment and enhanced bioremediation, given the Site's geochemistry (NDEP 2011). The Site's geochemistry, in particular high TDS and sulfate concentrations, may make implementation of in situ reductive treatment and enhanced bioremediation challenging; however,* ***it is not considered a fatal flaw****. The viability of these technologies with respect to site-specific conditions including the geochemistry will be further evaluated in this document and through subsequent bench-scale and pilot testing as appropriate*.

    Please perform some basic calculations regarding complete reduction of electron acceptors. Concentrations of sulfate have been measured as high as 3,700 mg/L; each mole of sulfate consumes four moles of H_2 in the reaction:

$$2SO_4^{-2} + 3H^+ + 8H_2 \dashrightarrow H_2S + HS^- + H_2O$$

    The optimal ORP range for reductive dechlorination is -220 to -240 mV. To achieve this, all oxygen, nitrate, ferric iron, manganese, and sulfate must be reduced. Then, there is the matter of sulfide precipitation occluding porosity, as well as the biotoxicity issues with sulfide. The NDEP is concerned about the viability of reductive treatment to completely dechlorinate PCE in this setting.

66. Page 28, Section 8.2.1 **(Alternative 1** – No Action) states that Alternative 1 (no action) presumably would not be acceptable to the NDEP (or the community). This is a correct presumption.

67. Page 29, Section 8.2.2 **(Alternative 2A** - ISCO at plume hotspot and the plume upgradient of the residential area, ICs, SSD systems, and MNA)
    The CAP defines the term "**hotspot**," as areas of the plume where PCE concentrations exceed 1,000 µg/L. There are areas of the plume within the neighborhood that fall under this definition.

    Please provide references for other sites in similar geologic settings (heterogeneous alluvial deposits) with similar geochemistry and similarly sized PCE plumes where use of oxidants has been successful in the complete oxidation of PCE (i.e., no buildup of other toxic volatile organic compounds [VOCs]). Also, please provide specific sites where project team members have successfully implemented chemical oxidation on this scale.

The NDEP concurs with maintenance of existing SSD systems and installation of additional systems if the concentrations of PCE in indoor air are found to exceed the interim action level of 32 µg/m3 in any other homes. Reference the ***Draft Work Plan for Mitigation of Indoor Air and Well Water***.

68. Page 26, 1st paragraph states that "*Under this alternative, a chemical oxidant is injected into the subsurface in the plume hotspot to treat the greatest mass of PCE, and in a line of injection wells perpendicular to the plume upgradient of the residential area...*"and "*Abiotic MNA occurring as a residual effect of treatment and subsurface alteration could further reduce concentrations of PCE in groundwater.*"

    The NDEP agrees with the concept of injections that are NOT in the residential neighborhood.

    Permitting issues should be addressed at the onset of investigating any alternative requiring injections. The Bureau of Water Pollution Control (BWPC) handles underground injection control (UIC) permitting. See: http://ndep.nv.gov/bwpc/uic_overview04.htm

69. Page 31, 1st bullet states that "*Hydrogeology between the existing monitoring wells is not well defined, and potential impermeable lenses in the aquifer may influence injection.*"

    Please define "well defined." The NDEP notes that the **main characteristic** of the unconsolidated alluvial deposits across the site is **heterogeneity**. It is not practical (or feasible, cost-wise) to precisely define the hydrogeology for every point across the site. Inferences must be made by experienced geologists/hydrologists. However, a more detailed study of the lithology and contaminant distribution is advisable for the treatment area(s).

    The main challenge encountered with ISCO (or injection of reductants) is achieving effective distribution of the injected material. Field tests are required to evaluate whether the interbedded silts and clays (along with caliche lenses) can be effectively treated in situ.

70. Page 31, State Acceptance states that "*However, the NDEP has expressed initial reservations regarding the environmental impacts of this alternative and indicated that it will require a contingency plan (NDEP 2011).*"

    The NDEP is concerned with safety issues regarding the use of any oxidant. A contingency plan will be needed. The NDEP also notes that there is no way to control (or know) the migration routes of the injected materials. **Tracer tests** should be considered to evaluate possible migration pathways.

71. Pages 31-32, Section 8.2.3 (**Alternative 2B** – ISCO, ICs, SSD Systems, MNA). The CAP also notes that "*Given the depth to groundwater, injectate migration via utility corridors is not expected; however, careful planning would accommodate conservative safety requirements. It was assumed that all injection wells would require three rounds of injection of potassium permanganate.*"

    Under this alternative, oxidant would be injected across the areal extent of the plume, everywhere concentrations in groundwater exceed 100 µg/L. The NDEP notes that this alternative proposes injections of oxidant within the residential neighborhood, with an estimate of three injections over time. Unanticipated migration of injected solutions argues against the safe use of oxidants within a residential neighborhood. There are explosion hazards associated with hydrogen peroxide (including Fenton's reagent) and persulfate solutions. Also, infrastructure in the neighborhood and a shallow water table (8 to 19 ft bgs) in the neighborhood, raise additional safety concerns with this alternative.

72. Text for Alternative 2B, Page 32 continues, "*Indoor air sampling would be maintained until groundwater concentrations decrease to levels protective of indoor air (assumed to be 2 years).*"

Considering the concentrations in groundwater (as much as 3,500 µg/L measured in MW-18 within the residential neighborhood), has the equilibrium partitioning of PCE into soil gas and sorbed onto soil been considered? Vadose zone soils may act as both sink and source over time. Has this been considered in the estimate of 2 years to achieve the remediation standard for indoor air other than simply stating that "*PCE sorbed to soil may be released and require treatment.*"? Concentrations of PCE in soil gas at equilibrium with groundwater can be calculated. PCE in groundwater at 1000 µg/L was calculated to have an equilibrium concentration of 600,000 µg/m3 in soil gas at the interface (See: http://www.handpmg.com/lustline28-downward-migration.htm).

73. Pages 32-33, bullet at bottom/top of page states that "*Alternative 2B would present low-level risks to the community because the corrective action would be applied in situ in all areas of the Site... Drilling and injection equipment would be required to implement this alternative; however, risk to the community could be minimized through exclusion zones and other typical safety measures. Careful planning should be used when injecting near residences or underground utilities that could provide preferential pathways; given the depth to groundwater is in most cases below 17 ft bgs, preferential pathways via utility corridors are unlikely. A contingency plan detailing precautions that would be taken to ensure the safe application of chemical oxidant at the Site is warranted.*"

This alternative has serious safety issues and an optimistic estimate of how quickly the remediation standard for indoor air would be met. Check UIC permitting requirements and conduct some rough calculations on amount of oxidant needed. Also, the ROI for such injections seems unlikely to extend across a residential lot, assuming injection in the street right-of-way.

74. Page 34, Section 8.2.4 (**Alternative 3** – ZVI PRB, IC, SSD Systems, and MNA) states that "*Abiotic MNA would further reduce concentrations of PCE in groundwater and would be monitored.*"

Abiotic monitored natural attenuation (MNA) seems unrealistic, considering that there is little evidence of degradation of PCE after 40 years (assuming releases from the start of dry cleaning operations at the former APTC in the former Maryland Square Shopping Center).

75. Page 34, Section 8.2.4 (**Alternative 3** – ZVI PRB, IC, SSD Systems, and MNA) "*Bench-scale and pilot testing would determine the effectiveness, dosing rates, and any geochemical interference at the Site. High sulfate concentrations at the Site may impact barrier performance. If sulfate is reduced to sulfide it would react with the ZVI and reduce the available reactive surface. Additional ZVI may have to be provided to compensate for this. When sulfate reduction occurs in PRBs, it is generally observed in the first few inches of the barrier. Precipitation of iron sulfides (FeS and FeS2) would reduce permeability of the barrier over time. If bench-scale testing reveals the possibility for such precipitation, other*

treatment media could be used upgradient of the PRB to remove sulfate. If bench-scale testing is successful, pilot studies would be conducted in the area before full-scale implementation to verify applicability of bench-scale results to field conditions. These tests would also allow for refinement of costs. The costing purposes installation of a replacement PRB was assumed after 30 years."

High concentrations of sulfate in groundwater can severely affect the reactivity and permeability of, and flow through, ZVI PRBs. Please provide references to case studies where PRBs have proven to be successful when sulfate concentrations are 2,000 to 4,000 mg/L, alkalinity is high (200 to 300 mg/L), and concentrations of TDS are also elevated.

Unanticipated issues related to high concentrations of sulfate upgradient of the barrier, with reduction of sulfate to sulfide and then to FeS. Precipitation resulted in long-term impact on barrier reactivity and permeability. See http://www.frtr.gov/pdf/meetings/k--ghosh_09jun04.pdf

76. Page 36, State Acceptance states "*However, NDEP has indicated that this technology does not seem viable given sulfate conditions at the Site (NDEP 2011). While high sulfate and electron acceptor concentrations at the Site would require the addition of more ZVI, chemical reducing agents have been utilized effectively at sites with high sulfate. The feasibility of this alternative and the effect of sulfates can quickly be determined through bench-scale testing.*"

The NDEP has performed calculations regarding the use of another reductant (HRC-X). Prior to any testing, please provide **calculations, along with references** on the successful implementation of a ZVI PRB under similar geologic, hydrological, and geochemical conditions.

Please provide references for case studies where *"chemical reducing agents have been utilized effectively at sites with high sulfate."*

77. Page 36, Section 8.2.5 (**Alternative 4** - Sparge Curtain, ICs, SSD Systems, and MNA). *For consideration on this alternative, it was assumed that air would be injected into the groundwater in a line of AS wells perpendicular to the plume, creating a sparge curtain to strip PCE in groundwater as it flows into the residential area. SVE wells would be utilized to extract the PCE-laden sparged air as it migrates upwards into the vadose zone. Clean water would flow from the downgradient edge of the sparge curtain.*

Groundwater mounding formed as a result of sparging can affect groundwater flow. Such mounding has the potential to significantly modify the flow regime to the extent that the system design is rendered inadequate. (See more discussion at http://epppublications.com/Documents/14-02-22.pdf). Please provide a discussion of how the possible diversion of the contaminant plume due to groundwater mounding would be monitored and prevented. Also provide references and information on successful use of sparge curtains for sites with plumes of similar magnitude.

78. Page 39, Section 8.2.6, (**Alternative 5** - Extraction and Treatment, ICs, SSD Systems, and MNA). The second paragraph of this section states that "*Groundwater would be extracted from within the plume, treated to remove PCE, then re-injected outside the plume. Extraction and injection wells would be installed where possible and would cover the entire plume. An estimated 14 extraction wells and 15*

injection wells would be needed. Two treatment systems (one located in the mall parking lot and the other on the golf course property) would be considered. Treated water would be delivered to injection wells surrounding the PCE plume. It is expected that wells in residential areas would be installed in right of ways."

The NDEP envisioned a transect of pumping wells just upgradient of the residential neighborhood, with reinjection within the plume just downgradient of the extraction wells to: (1) help reduce stagnant zones; and (2) help flush out contaminated groundwater under the neighborhood.

Re-injection of poor-quality water back into the same "aquifer" is acceptable to the NDEP BWPC, upon issuance of a UIC permit.

This configuration of pumping wells would serve both as **containment and remediation,** and would prevent the greatest mass of PCE (currently west of and underneath the mall) from migrating into the residential neighborhood.

79. <u>Page 39, fourth paragraph</u> states that "*Given the geology at the Site, there will likely be localized dewatering of the formation at each extraction well. The sorbed PCE in the dewatered zone could recontaminate groundwater when pumping stops. To reduce the impact of this phenomenon, it is expected that pumping will be pulsed rather than continuous. This aquifer has exhibited slow recharge of groundwater, indicating low hydraulic conductivity, which may make this technology difficult to implement and lead to a long remedial timeframe.*"

The NDEP assumes that pumping tests and a detailed profiling of lithology and contaminant distribution will be necessary for all remedial alternatives (except the no-action alternative). "Smart pump and treat" should be evaluated for implementation at this site (see Hoffman, 1993). Extraction and ex situ treatment for chlorinated solvents has been used successfully at other sites in Nevada (see NDEP Facility ID D-000084, D-000544 for examples), although the Maryland Square PCE plume is of greater magnitude than these other sites.

80. <u>Page 39, fourth paragraph</u> states that "*The remedial duration is calculated at more than 40 years based on basic equilibrium partitioning and required pore volume exchanges. However, it is expected that the actual remedial duration will be much longer because of* ***aquifer material heterogeneity*** *and the* ***tendency for fine-grained materials to be cleaned up slowly.***"

The NDEP notes that the heterogeneity of the alluvial deposits and tendency of fine-grained materials to be slower to clean up are issues that <u>**affect all the alternatives**</u> discussed in the CAP

81. <u>Page 39, fifth paragraph</u> states that "*The potential for dewatering to compromise the geotechnical stability of subsurface clay and silt lithologic zones will also require careful evaluation to ensure protection of surface structures and infrastructure.*"

The NDEP is unfamiliar with any remediation site in the Las Vegas Valley that has suffered subsidence as a result of groundwater extraction for treatment. Please provide references and information to document such a response. Also, provide information documenting the presence of 2:1 clays in the shallow groundwater system at the Site.

82. <u>Page 39, fifth paragraph</u> states that "*Discharge or reinjection of treated groundwater may be problematic due to elevated concentrations of TDS in extracted groundwater. Re-injecting groundwater containing elevated TDS (even if from the same groundwater source) or conducting surface discharge is limited by regulation and may not be permitted.*"

    Treatment of water for TDS (or other natural condition) is not needed as long as the water is reinjected into the same water-bearing unit (NDEP BWPC)

83. <u>Page 41, first paragraph</u> states that "*Hydrogeology between the existing monitoring wells is not well defined, and potential impermeable lenses in the aquifer may influence hydraulic capture. The high TDS may lead to precipitate formation and fouling of the extraction and treatment equipment, which can be costly.*"

    The NDEP notes that geologic heterogeneity and groundwater geochemistry (high concentrations of sulfate, alkalinity, TDS, etc.) may adversely affect many of the remedial technologies discussed in the CAP for Groundwater.

84. <u>Page 41, Section 8.2.7 (**Alternative 6:** In Situ Enhanced Bioremediation, ICs, SSD Systems, and MNA)</u> states that "*enhanced bioremediation would be employed in areas of the plume hotspot and upgradient of the residential area to treat groundwater as it flows into the residential area (where the aquifer conditions are amenable to reductive dechlorination as described in Section 4).*"

    Re: Section 4; **see NDEP comment 39**: The NDEP notes that there are **only two wells** that have average ORP values less than 0 mV; **MW-10** and **MW-11**. MW-11 contained petroleum product (weathered gasoline), which is an electron donor during aerobic degradation and which typically reduces ORP in the area surrounding the product. The NDEP notes that 29 of the 33 monitoring wells have median values of ORP greater than 100 mV.

85. <u>Page 41, last paragraph</u> states that "*Enhanced bioremediation would be applied through injection of substrates or microbes in the plume hot spot where practicable based on preferable ORP values and where logistically practicable, including at the Property and in streets, public right of ways, and parking lots in the Boulevard Mall.*"

    For this alternative, as for the earlier discussions of alternatives involving in situ oxidation and reduction, the difficulty of effectively distributing the injectate into a highly heterogeneous package of unconsolidated geologic deposits is perhaps the greatest challenge for ***any*** in situ treatment that relies upon injection of substances. Injections would require UIC permitting.

86. <u>Page 42, first full paragraph</u> notes that "*The high sulfate concentration found at the site would increase the amount of substrate required.*"

    The NDEP notes that it is not just the sulfate. Considering the median values for DO (3.5 mg/L), nitrate (5.9 mg/L), alkalinity (220 mg/L), and sulfate (1,700 mg/L), there is an abundance of naturally occurring electron acceptors that must be satisfied before redox conditions for complete reductive dechlorination (approximately -220 to -240 mV) are attained.

Prior to conducting bench-scale tests, a thorough search of the literature should be conducted for sites where successful use of in-situ bioremediation (ISB) has been documented under similar geologic, hydrological, and geochemical conditions.

87. Page 43, fourth complete bullet states that "*Hydrogeology between the existing monitoring wells is not well defined, and potential impermeable lenses in the aquifer may influence the injection. High sulfates may be problematic and require additional substrate; given sulfate concentrations at the Site, EHC is likely one of the few substrates that will be effective.*"

Please provide references and information on EHC and why it may be effective. **Provide calculations** on the amount of substrate needed to overcome median concentrations of electron receptors at the site, as well as the mass required to remediate the dissolved-phase PCE.

88. Table 8-1. Comparison of Alternatives Summary. Although this table summarizes the evaluation criteria for each alternative, neither this table nor Table 7-1 provide a list of the data needs for each alternative. The data needs must be listed, then reviewed against the data that are currently available, in order to determine "data gaps."

Under the column, "state acceptance," please specify the nature of NDEP's concerns, not just "NDEP expressed concerns regarding the feasibility of this alternative." For example, under **Alternative 3**, the cause for NDEP's concern should be specified (e.g., high concentrations of sulfate and other electron acceptors; formation and precipitation of sulfides that may compromise permeability of the PRB; passivation, failure to achieve complete reductive dechlorination, resulting in breakthrough of chlorinated degradation products, etc.)

89. Table 8-2. Summary of Technology Advantages and Disadvantages. **Please do not simply list "preferred by NDEP"** or **"NDEP does not support this technology at the site."** Describe the ***reasons*** that cause concern for the NDEP; for example, for ISB to be effective, all electron acceptors must be satisfied in order to attain anaerobic conditions suitable for complete reductive dechlorination of PCE and its chlorinated degradation products.

Section 9, Recommendations

The CAP fails to provide what data are needed for each alternative. The CAP also does not provide a summary of the data that are currently available. Both are needed to determine "data gaps." One example of data needed could be use of tracer tests to evaluate flow between existing monitoring wells and between any additional borings installed at the Site.

90. Page 48, **Section 9**, Recommendations, first paragraph states that "*This section provides a list of data needs and field activities recommended for obtaining needed data. These data gaps* ***disallow a sufficient understanding of the Site conditions pertinent to****: (1) development of a human health risk assessment, (2) a complete evaluation of remedial alternatives, and (3)* ***confirmation of site parameters*** *essential for development of a final remedial design.*"

"These data gaps disallow a sufficient understanding of the Site conditions pertinent to..." What does this statement mean? The "understanding" of exposure due to inhalation of PCE vapors entering homes as a result of vapor intrusion is well established at this site (i.e., there is a mature CSM for this site). Please describe, *explictly*, what a "sufficient understanding of the Site conditions" is envisioned to be. The existing data clearly document PCE concentrations in indoor air at a level exceeding a 10^{-4} risk level (and as much as 110 µg/m3) in some homes. Additional studies of subslab vapors, soil gas, and groundwater are not needed to perform a HHRA now.

(1) As previously noted by the NDEP, there are indoor air data for 97 homes, some data for soil gas and quarterly data for groundwater. No reason is provided as to why these data cannot be used for an initial risk assessment. This risk assessment should be updated as new data are collected, but must not be postponed until then.

(2) Here, the NDEP agrees that additional hydrologic and lithologic data are needed in order to more fully evaluate all remedial alternatives. Particular studies, such as tracer studies, deployment of passive diffusion bags (PDBs) or other method to evaluate PCE stratification within wells, separate discrete-depth vertical sampling, aquifer pumping tests, evaluation of ROIs, etc. should be described in the CAP (or at least as an appendix to the CAP or in a summary table providing some details).

(3) It is unclear what is meant by "confirmation of site parameters;" the NDEP notes that aquifer tests (pumping tests) and a detailed analysis of lithology and contaminant distribution in the treatment area are likely needed. The NDEP also notes that there is a large data set for field parameters (pH, ORP, DO, etc.) and a large set of analytical data for groundwater chemistry. Please ***specifically*** and ***explicitly*** describe what is meant by "confirmation of site parameters" and how that information will be used to make recommendations and inform decisions.

91. Page 48, second paragraph states that "*The **extent of groundwater contamination and how it impacts soil gas and indoor air are not fully defined** in the downgradient areas of the plume, **north of Cherokee Lane** in the residential neighborhood and across the golf course.*

The NDEP notes that, the extent of the PCE plume from the source area to at least as far as the golf course, the **extent of groundwater contamination** is well-defined on the north, west, and south by site monitoring wells. Data from other monitoring wells and borings that were installed for other sites located to the north and south of the plume, further assist in constraining the lateral boundaries of the Maryland Square PCE plume by showing nondetections for PCE[1]. **The northern boundary of the plume is constrained**, using data from several wells and one boring (grab sample).

Please describe what "not fully defined" means in this context. The extreme heterogeneity of PCE vapors in the vadose zone, combined with building-specific characteristics, **precludes using PCE concentrations in groundwater to accurately predict PCE vapors in the vadose zone at any given location or PCE concentrations in the indoor air of any specific house**.

There is no evidence that PCE contamination in groundwater extends farther north than currently delineated as nondetected (or very low detections, less than the drinking water standard of 5 µg/L) in wells MW-22 and MW-33, so please explain why "north of Cherokee Lane" is specifically identified here as a "data need." A March 24, 2008 report (URS) also included analytical data for a boring that was installed about mid-way between monitoring wells MW-32 and MW-33, along Spencer St. A grab groundwater sample from boring B-T2 contained 130 µg/L PCE. See Figure 2 in URS (2008) showing the location of boring B-T2 and the correct location of the golf course irrigation well, PW-1.

[1]Other sites providing such data include (1) the Sears UST site; (2) the former Dr. Clean, H-000511; (3) Boulevard Mall, H-000240; and (4) the "GAP" wells on the west side of Boulevard Mall.

Refer to the ***Draft Work Plan for Mitigation of Indoor Air and Well Water***, for proposed locations of additional groundwater monitoring wells.

If by asking the question "*how does the PCE in groundwater* ***impact soil gas****?*" is meant "*WHERE does the soil gas contain PCE vapors?*," that may prove to be an extensive research project to define the distribution of the "patchy fog" of vapors in the lithologically heterogeneous unsaturated zone and in utility corridors across the site. The data for indoor air and groundwater show that the highest concentrations of PCE in groundwater do not directly coincide with the highest concentrations of PCE in indoor air.

The NDEP collected soil gas data to (1) determine if PCE was volatilizing and accumulating in the vadose zone, and (2) estimate the possible indoor air concentrations using the USEPA's version of the Johnson-Ettinger model. Using the maximum concentration detected in the neighborhood (46,000 µg/m3), along with site-specific and some default parameters, the model very accurately predicted the maximum concentration of PCE found in indoor air.

The USEPA (2002) recommends that the potential for vapor intrusion be considered for structures lying within 100 feet of the boundary of the groundwater plume. Limited additional sampling of soil gas in some areas may be proposed, but the only way to know whether the ***indoor air*** of any given home is affected by vapor intrusion is to sample the indoor air. The unique characteristics of each home, along with behaviors and habits of the inhabitants, can lead to significant vapor intrusion effects to one home and none in an adjacent home. Wertz (2011) put it most simply when he stated: "I sample houses because that's where the people are."

Across the site, groundwater gradients and the PCE plume head nearly due east from the source area to the golf course. The role of golf course irrigation and how this may affect the flow of groundwater, the migration of the PCE plume, and migration of soil gas should be considered, however. The downgradient extent of the plume to the 5 µg/L boundary will be evaluated per the ***Draft Work Plan for Mitigation of Indoor Air and Well Water.***

92. Page 48, second paragraph states that "*The pathways of potential concern* ***relate to***[a] *volatilization of PCE from groundwater to soil gas and its transport to indoor air in homes and businesses. A work plan is being developed for an investigation to* ***determine the extent of PCE in groundwater***[b] *and* ***better understand the volatilization of PCE from groundwater into soil gas and its migration***[c] *and* ***transport into indoor air***[d]. *Data expected to be obtained via that effort* ***are needed to prepare the risk assessment***[e] *and* ***develop mitigation measures***[f] *for residential indoor air.*"

a. The NDEP notes that **<u>the</u> exposure pathway <u>is</u> inhalation** of PCE vapors that have intruded into a particular building. The use of "relate to" in describing this pathway is unnecessarily vague.

b. The Permanent Injunction (December 27, 2010) requires that a work plan to "*define the **downgradient extent** of the Site groundwater plume containing more than 5 µg/L of PCE*" be provided to the NDEP (and the Court). This delineation will likely require the installation of additional borings and monitoring wells near Eastern Blvd, on the eastern extent of the golf course, and perhaps farther east. Please reference the ***Draft Work Plan for Mitigation of Indoor Air and Well Water.***

   The apparent widening of the PCE plume in groundwater along the western edge of the golf course may best be explained by the seasonal irrigation (effects of which are easily seen in the annual water table fluctuations in wells MW-33, MW-27, MW-30, and other wells near the golf course). The infiltration of irrigation water may create local mounding or otherwise perturb the hydrologic flow in the immediate vicinity of the golf course.

   Nondetections for PCE in wells MW-22 and MW-33 constrain the northern boundary of the plume, whereas nondetections in wells MW-10, MW-16, MW-11, MW-28, and MW-29 constrain the southern boundary of the plume.

c. A "better understanding" of **volatilization of PCE from groundwater and into the vapor phase** can be obtained via calculations using Henry's Law, and the knowledge that diffusion-driven migration of vapor phase may lead to a vapor distribution that does not necessarily follow the concentrations in the groundwater (i.e., the "patchy fog" model). As for the migration of vapors; once liberated from groundwater, the PCE vapors will follow preferential pathways, unconstrained by the hydraulic gradient to which groundwater must attend. Movement of contaminant vapors via gaseous diffusion can be described by Fick's first law.

   There are many publications that describe volatilization and subsequent transport of the vapor phase; please **describe how and why additional data on this matter are needed to remediate groundwater at the site**.

d. The **transport of soil gas into buildings** is unique to the characteristics of a particular structure (e.g., HVAC system, cracks in slab, etc), along with the behavior of the inhabitants (e.g., leaving windows open or closed, etc.). Two adjacent homes can exhibit very different impacts from vapor intrusion as a result of building characteristics and inhabitant behaviors; that is, it is not possible to accurately predict which homes will have what concentration of PCE vapors in indoor air. (See "VI Assessment and Mitigation Decisions: Panel Discussion" USEPA Workshop, March 15, 2011).

e. Wertz (2011) stresses that "***The goal of a vapor intrusion assessment strategy is <u>not</u> to learn all there is to know about the VI pathway at the site, only to develop enough knowledge to properly manage risks.***" The NDEP notes that there are indoor air data for 97 homes; please explain why these data cannot be used to perform a risk assessment, and why detailed research is needed to "*understand the volatilization of PCE from groundwater into soil gas and its migration and transport into indoor air,*" instead of focusing on managing risk within each home across the site and remediating groundwater. Additional data for samples of indoor air may, however, be used to update the HHRA.

f. Mitigation measures for residential indoor air generally consist of installing an SSD system (also known as a radon mitigation system). There is standard guidance available from the USEPA, American Society for Testing and Materials (ASTM), and others. It is not clear what aspect of the data proposed here for collection, will be used to "develop mitigation measures for residential indoor air." **Please specifically describe how a "better understanding of volatilization" will be used to "develop mitigation measures for indoor air."** As previously noted, the only way to know the extent of vapor intrusion effects in any given home is to test the indoor air in that home, while carefully evaluating the potential for background sources (i.e., consumer products containing PCE or other VOCs) within the home.

93. Page 48, second paragraph states that "*Additional data representing hydraulic flow parameters for the diverse range of soil types at the Site are needed for evaluation of the remedial alternatives and development of the remedial design.*"

The NDEP agrees that the collection of aquifer test data (e.g., pumping tests, etc.), along with detailed lithologic and contaminant distribution data in the treatment area(s), is needed for development of the remedial design. However, aquifer tests, tracer tests, etc. should be proposed in the CAP and detailed as individual work plans in an appendix to the CAP.

94. Page 48, first bullet states that "*Indoor air data are needed to* ***evaluate current residential conditions***[a] *and* ***evaluate the efficacy of mitigation systems previously installed by NDEP***"

The currently available data for indoor air may be used to conduct a risk assessment now; additional data to be collected "at least annually" (per Section III.A.1.a. of the Permanent Injunction), may be used to assess current conditions and update the risk assessment.

The NDEP collected post-mitigation samples of indoor air to assess the efficacy of the SSD systems; systems that were not achieving sufficient reductions in PCE vapors in the indoor air were performance-tested, optimized, and retested (BAI, 2010). Re-sampling of all homes (with consent of the home owner) overlying the plume is required "at least annually." As data are collected, conditions may be re-evaluated, along with the continued efficacy of the SSD systems.

The NDEP notes that a HHRA can be conducted using the currently available data. The Permanent Injunction requires indoor air sampling, at least annually. These data can be used to update the HHRA performed using the existing data.

95. Page 48, first secondary bullet states that "*Indoor air sampling and* ***subslab sampling*** *in the residential area* ***are needed to verify results from previous investigations****, re-assess how well previous data represent current conditions at the Site, and establish a baseline for monitoring remedial progress.*"

Verification of existing data is not needed in order to conduct a HHRA. The existing data for indoor air should be used to conduct a HHRA now. Subslab data are not needed to conduct a HHRA.

The NDEP notes that there is considerable debate regarding the utility of subslab samples. The spatial variability of vapor concentrations across the slab has been shown to be several orders of magnitude. Unlike indoor air (which is generally well mixed), vapors in subsurface soils show a large amount of spatial variability (Johnson 2001). McHugh (2007) highlighted as a key point, that the spatial variability in subsurface media is much higher than the temporal variability in indoor or ambient air. Given such spatial variability in the subsurface, McHugh (2007) noted that "*lots of sample locations are required to understand VOC concentration in subsurface*," but that, for indoor air, a "*single sample can accurately characterize well-mixed space*." Ekland and Simon (2007) noted that "*The soil-gas and subslab soil gas data at the site indicate a surprisingly large degree of spatial variability*." Siegel (2009) noted that "*subslab results have been found to vary significantly under the same structure, even beneath small individual residences.*"

The issue of background sources contributing to concentrations of PCE in indoor air needs to be considered, using in-home surveys, discussing with the homeowner that importance of not using certain products during the sampling period, and checking for VOCs using a mini-Rae part per billion (ppb) photoionization detector (PID) before and after sampling. In some cases, perhaps a subslab sample may be collected, but the NDEP does not consider it necessary in order to conduct a HHRA. Additional samples of indoor air can be used to augment the existing data and update the HHRA prepared using the existing data.

96. Page 48, second secondary bullet states that "*Similar indoor air and subslab data are needed for the Boulevard Mall to determine whether engineered control systems are needed to mitigate indoor air in order to address potential risks under current conditions.*"

    In general, in commercial/industrial facilities, Occupational Safety and Health Administration (OSHA) standards apply and establish "allowable" concentration limits. The NDEP is focused on assuring remediation (and mitigation) on behalf of the homeowners. Subslab data are not needed to determine whether systems are needed to mitigate indoor air at the mall or in the homes, unless there is indication of in-home sources of PCE.

97. Page 48, second primary bullet states that "*Soil properties have not been well characterized for the unsaturated and saturated heterogeneous soils across the Site. Insufficient physical, flow, and contaminant distribution data have been obtained in the unsaturated and saturated zones beneath the Site.*"

    The NDEP notes that unsaturated soils in the **source area** have been well-characterized with respect to lithology, as well as the distribution of PCE. Elsewhere across the site, lithologic data are available only at monitoring wells and soil borings. The NDEP agrees that a detailed determination of contaminant distribution and lithology will likely be needed in the treatment area(s). Additional hydraulic data, such as obtained by pumping tests, are also needed.

98. Page 48, last bullet states that "*Additional soil testing (standard measurements of porosity, grain size distribution, organic carbon, and bacterial analyses) is needed to better understand the geotechnical properties and lithologic conditions of the heterogeneous subsurface soils **as related to flow dynamics, contaminant transport, and vapor migration;** this information **is necessary** to assist in evaluating remedy selection and development and implementation of the remedial design.*

The NDEP notes that it likely will not be possible to collect enough data to *completely* characterize vapor migration in the subsurface at the site, nor is this information needed to evaluate and design a remedy for groundwater.

Vapors are not constrained by hydraulic gradients like groundwater, and may instead follow utility corridors and other preferential pathways, mainly by diffusion, but advection (especially in the zone of building influences) may also occur. The spatial variability of vapor concentrations in the subsurface is expected to be extreme, both laterally and vertically. So much so that **defining the distribution of subsurface vapors is only practical in a very general way, and it should not be listed as "necessary" for evaluating, developing, and implementing a remedy for groundwater.**

99. Page 48, last paragraph states that "*Given the concentrations of PCE in groundwater at the site, the subsurface conditions, and the **various receptor pathways**, an integrated approach to remediation or a combination of general response actions likely will be required.*"

Please explain what "various pathways" are being referred to here. The **known receptor pathway** is "inhalation of chlorinated solvent vapors" that have intruded into indoor air of homes overlying the Maryland Square PCE plume. A **possible receptor pathway** is ingestion of PCE-contaminated groundwater obtained from shallow domestic wells, which may be present at some properties east of Eastern Blvd; that topic is being addressed in a separate work plan (Provide reference to the ***Draft Work Plan for Mitigation of Indoor Air and Well Water)***. The NDEP does agree, however, that a combination of response actions may be required.

100. Page 48, last paragraph states that "*...bench-scale **or pilot tests** should be conducted to evaluate the potential of a corrective action to meet project needs. Tests for air permeability, ROI, and groundwater production are needed. Production tests are necessary to understand the flow capacity and area of influence in the variety of soil types that exist at the Site, and to predict the locations and effects of the complex flow boundary conditions for developing the remedial design for a groundwater remedy.*"

The NDEP notes that because distribution in the subsurface is the primary challenge for any injection (ISCO or reductants), field-scale tests will likely be needed. Laboratory tests alone cannot predict if the distribution issues can be overcome. A tracer test may be useful at the field scale.

101. Page 49, first full paragraph states that "*If testing for chemical oxidation and sparging technologies proves unsuccessful or insufficient as an overall strategy for treatment of the Site, additional testing for a ZVI PRB, extraction and treatment, and enhanced bioremediation will be considered.*"

The NDEP suggests doing some calculations to estimate how much material (whether HRC, EHC, or ZVI) would be needed to (1) overcome all the electron acceptors, and (2) completely dehalogenate the PCE. The NDEP used the Regenesis calculator on-line and, with site-specific chemistry and some general assumptions, received an estimate of nearly 1 million pounds ($8.7 million) of HRC-X would be required...All testing should be done concurrently, rather than sequentially, in order to not further delay remedy selection and implementation.

102. Page 49, Section 9.3 provides a proposed schedule for the listed tasks. However, the NDEP does not see pumping tests, tracer tests, geotechnical testing or other such testing listed here. Also, it seems that one month may be an inadequate amount of time for field pilot testing, particularly for injection followed by testing to verify distribution and efficacy of the injections.

Other Critical Comments

103. The NDEP notes that the draft CAP does not propose evaluation of the relationship between the shallow groundwater system and the deeper aquifer. Nested wells or piezometers could be installed in the vicinity of the golf course irrigation well, PW-1. Additionally, a video survey of well PW-1 could be performed to evaluate the integrity of the well casing. Understanding the relationship between the shallow and deep groundwater system may be important is addressing groundwater contamination, and should be considered in the CAP.

EXAMPLE TABLES

Data Needs for each Alternative

REMEDIAL ALTERNATIVE	DATA NEEDED
(2A) ISCO in "hotspots" and Residential Areas, SSD Systems	Tracer test, aquifer pumping tests, vertical delineation of lithology and contaminant distribution in the treatment areas, TOC, geotechnical testing
(2B) ISCO, ICs, SSD Systems	Tracer test, aquifer pumping tests, vertical delineation of lithology and contaminant distribution in the treatment area, TOC, geotechnical testing
(3) ZVI PRB, ICs, SSD Systems	Tracer test, aquifer pumping tests, vertical delineation of lithology and contaminant distribution in the treatment area, TOC, geotechnical testing
(4) Sparge Curtain, ICs, SSD Systems	Tracer test, aquifer pumping tests, vertical delineation of lithology and contaminant distribution in the treatment area, TOC, ROI, air permeability tests, geotechnical tests
(5) Extraction & Treatment, ICs, SSD Systems	Aquifer pumping tests, ROI, air permeability, tracer test, geotechnical test, vertical delineation of lithology and contaminant distribution in the treatment area
(6) Enhanced ISB, ICs, SSD Systems	Bacterial analysis, organic carbon, bench-scale testing, field-pilot testing, tracer testing, vertical delineation of lithology and contaminant distribution in the treatment area

Existing Data

DATA TYPE	PARAMETERS/NUMBER OF LOCATIONS	FREQUENCY /STUDY
CVOCs in Groundwater	Method 8260B analytical data for groundwater samples from 32 wells (assume MW-4 out of service; MW-11 sampled annually)	Annual to quarterly data
CVOCs in Soil	77 samples from 29 borings in source area	Converse, 2003; URS, 2007
Field Parameters	DO, ORP, temperature, pH, conductivity, TDS, turbidity, water level at 32 wells	Annual to quarterly data, n > 160 or more
Inorganic parameters	Fe-total, Mn-dissolved, chloride, nitrate (NO3 as N), sulfate (SO4), alkalinity, TOC	Irregular, n >32 or more
Bacterial	DHC bacteria, two wells (MW-12, MW-13)	URS, 2005
Geotechnical	Soil mosture, grain-size distribution, bulk density, porosity	Converse, 2004; URS, 2007d
Aquifer tests	Slug tests	6 wells, Converse, 2004
Tracer tests	None	
TOC	look up and fill in	
Ambient Air	1 sample, summa & TO-15	BAI, March 2010
Soil Gas	32 samples from 16 borings	URS, 2007
Indoor Air	97 homes, 2 schools, summa & TO-15	Two phases, plus additional IA for mitigated homes (SSD systems installed)

PART B: CORRECTIONS AND SUGGESTED REVISIONS

Executive Summary

104. No minor comments on this section.

Section 1, Introduction

105. Page 1, first paragraph. Text states that "*PCE-contaminated groundwater was initially reported to the Nevada Department of Environmental Protection (NDEP) in a spill report dated November 29, 2000, by Converse Consultants (Converse).*"

Please specify that the historical release of PCE was reported upon discovery by Converse, and was based on a groundwater sample collected during an ESA **at the source area** (i.e., former APTC at the former Maryland Square Shopping Center).

106. Section 1.2, page 1. The text states that "*The former APTC facility has been identified **by NDEP** as the source of PCE contamination that forms the Maryland Square PCE plume in the shallow groundwater (Figure 3).*"

The data, not the NDEP, identify the source area. Revise this sentence to state "The **analytical data for soil and groundwater indicate** the former APTC facility as the source of the Maryland Square PCE plume."

107. Section 1.2.2, page 2. Text states that "*the **facility** was owned by the Maryland Square Shopping Center, LLC until the Clark County School District (CCSD) purchased the property in 2002.*"

Here, "facility" should be replaced with "Property."

Section 2, Physical Characteristics of the Study Area

108. Section 2.1. Incorrect name; it is the Nevada **Division** of Water Resources

109. Section 2.2, Site Geology, page 6. Geologic terms, as well as other words, are misused in this section (shown in red font below). The current text states:

"*The geology of the Site consists of interbedded sequences of sand, sandy silt, sandy clay, and silty clay with frequent zones of caliche and intermixed gravel scattered throughout. Lithologic data are available in borehole logs from 33 monitoring wells installed at the Site between 2000 and 2008. The borehole logs and well construction diagrams for all monitoring wells at the Site are provided in Appendix A. Additional lithologic information was obtained from 29 soil borings drilled for subsurface characterization of the former APTC area, and from borings installed for active soil-gas sampling in and adjacent to the residential neighborhood. Figures 8 and 9 show cross sections prepared by URS (2007d) representing the downgradient area east of Algonquin Drive. Figure 8 shows that sediments along Algonquin Drive consist of gravelly sand and grade into silt in the area of wells MW-23 and MW-25, and then to clay at approximately 10 ft bgs in the area of wells MW-26 and MW-27. Figure 9 shows gravelly sand in the upper 5 to 10 ft along Algonquin Drive and silty sand in the upper 10 to 12 ft along Seneca Drive.*

Total depth of monitoring wells at the Site vary from 20 to 50 ft, although most wells are completed at depths between 30 and 35 ft. Heterogeneous mixtures of lower permeability clays and silts (silty clay, sandy clay, clayey silt, and sandy silt) dominate the saturated intervals across most of the site. An apparent, alluvial stream-channel sand meanders through the area of the former APTC facility and portions of the Boulevard Mall in the upper 1 to 5 ft of the saturated zone, as evidenced in the borehole logs of wells MW-7, MW-8, MW-9, MW-10, MW-11, MW-12, MW-13, MW-14, MW-15, MW-20, MW-23 and MW-25. Sands exist in the lower portions of wells MW-12, MW-14, MW-20, MW-23, MW-25, MW-28, MW-30, and MW-31, as shown in the corresponding borehole logs. The borehole logs for wells PT-1 and PT-2 at the National Golf Course indicate that below 80 ft bgs, the geology consists of interbedded red clay, sand, gravel, and caliche to at least 750 ft bgs.

"**Sequence**" has specific meaning in geology and is incorrectly used here. "**Frequent**" and "**vary**" are improperly used to mean "common" and "range." "**Mixtures**" is not a proper geologic description. It is unclear what "saturated ***intervals***" are being specified here. An "***apparent alluvial stream channel sand meanders...***" should be described as sandy deposits of a possible paleochannel. Unconsolidated deposits along Algonquin are described by URS (2007) as **gravelly, silty sand** grading into silt and sandy silt. "Caliche" is <u>not listed</u> in the borehole log for PW-1; rather, the dominant lithology is clay/shale (reddish color) with some sand and gravel from 0 to 706 ft, and the main water-bearing gravel layer from 706 to 746 ft bgs.

Suggested rewrite follows:

Lithologic data are available for borehole logs from 33 monitoring wells (installed at the Site between 2000 and 2008), as well as 16 borings installed for collection of soil vapor samples (URS 2007x) and 29 borings drilled to characterize the source area (URS 2007x). The geologic deposits at the Site consist mainly of interbedded sands, sandy silts, sandy clay, and silty clay, along with some discontinuous zones of caliche and gravely sands. Gravels are less common in the aquitard than in the deeper aquifer. The borehole logs and well construction diagrams for all monitoring wells at the Site are provided in Appendix A.

URS (2007x) provided geologic cross sections that show deposits underlying the area along Algonquin Drive consist mainly of gravelly to silty sand that grades into sandy silt in the area of wells MW-23 and MW-25 (Figure 8). Farther downgradient, in the area of wells MW-26 and MW-27, these deposits grade into silty clays below the water table (approximately 10 to 12 ft bgs). Cross sections drawn perpendicular to the longitudinal axis of the PCE plume show gravelly to silty sands in the upper 5 to 10 ft along Algonquin Drive and predominantly silty sands in the upper 10 to 12 ft along Spencer Street (Figure 9).

Total depth of monitoring wells at the Site ranges from 20 to 50 ft, although most wells are completed at depths between 30 and 35 ft. Lower permeability clays and silts (silty clay, sandy clay, clayey silt, and sandy silt) dominate the saturated zone of the shallow groundwater system across most of the Site; however, the upper few feet of this zone consists of sands and silty sands in the source area and extending eastward across the Boulevard Mall property, and into the western portion of the neighborhood. This mainly sandy zone may represent portions of a paleochannel within the alluvial deposits.

Borehole logs for irrigation wells PW-1 (DWR #5675) and PW-2 (DWR #16296) for the Las Vegas National Golf Course are driller's logs, and, therefore, fairly generalized. The lithology in PW-1 is described as mainly clay/shale deposits (reddish color) with some sand and gravel "streaks" from 0 to 706 ft, and the main water-bearing gravel layer from 706 to 746 ft bgs. The well seal extends from the ground surface to 130 ft, with a screened interval from about 500 to 746 ft. The lithologic description for PW-2 notes a greater occurrence of caliche zones throughout much of the boring (total depth = 620 ft), but in particular above about 250 ft depth. Red clay and sandstone are listed as the dominant lithologies on the driller's borelog, along with a screened interval from 220 to 620 ft.

110. Section 2.3, Hydraulic Properties of the Shallow Groundwater System. Depth to groundwater generally ***ranges*** from 9 to 28 feet across the site, but ***varies*** annually within each well.

111. Page 7, 1st paragraph states: "*With the complex geology, the rate of groundwater flow within the shallow saturated zone varies, with preferentially higher flow rates within the gravelly sands and lower flow rates within silty to sandy clays. However, due to the frequent occurrence of scattered pea gravel and caliche within the mixed clays and silts, in combination with calcic water (which minimizes swelling of the clays), hydraulic conductivities within silty clay intervals may be relatively high (within the range of 0.01 to 1.0 ft/day) along predominant flow paths occurring along soil partings.*"

Please eliminate incorrect word usage and nonstandard terminology, such as "soil partings" which is a seldom-used term in pedology to describe voids that forms in soil horizons as peds form (aggregations of soil particles). "Soil partings" has nothing to do with flow of groundwater through the saturated unconsolidated alluvial deposits. Why is this (and other) inappropriate geologic terminology repeated throughout discussion of groundwater flow in this CAP? An experienced geologist should revise this discussion so that appropriate technical terminology is used.

The NDEP suggests the following rewrite:

Groundwater likely exhibits a range of flow velocities within the generally unconsolidated and heterogeneous geologic deposits that host the shallow groundwater at the Site. Higher rates of flow occur through the coarser grained layers (sands and gravels) and lower rates of flow through the finer grained layers (silty sands, silts, and clays). Data from two wells, USGS 43 and USGS 5 (Leising 2004) indicate that shallow groundwater northwest and southeast of the Site may best be characterized as a calcium-magnesium sulfate water, as discussed below in Section 2.4.

Section 3, Nature and Extent of Contamination

112. **Section 3.1 needs to be rewritten using known facts and standard geologic terminology.**

"**Soil partings**" and "**desiccation partings**" and "**differential stress cracks**" are nonstandard terms that do not apply to groundwater flow systems. "Soil partings" is a term used (rarely) in pedology in discussing the structure of soil (specifically, the pore voids that develop around soil peds). None of these terms are commonly used in discussing groundwater flow. Geologists do not typically refer to "mixtures" of sand and gravel, so it is difficult to determine if the writer meant to say "interbedded sands and gravels" or "layers and lenses of sandy gravel."

The chemical type of groundwater is "calcium-magnesium-sulfate" water; the term "**calcic water**" is not commonly used in the Unites States to describe the chemistry of groundwater.

Regarding swelling clays: Is there documentation of 2:1 clays in the alluvial deposits at the Site?

Section 4, Contaminant Fate and Transport

113. Page 12, third paragraph states "*The PCE plume is believed to have initially migrated through the preferential path of the sand and gravel portions of the Las Vegas Wash Aquitard (the shallow groundwater system). Although these intervals are poorly sorted, with up to 30% silt or clay present, these sand/gravel facies are the higher permeable portions of the aquitard and would allow migration at the required rates to produce the plume dimensions observed by 2008, and as indicated by the PCE detected at PW-1 in 1990.*"

Please rewrite this paragraph, using proper geologic terminology and correct word usage. Interbedded sands and silty to sandy gravels likely provide a preferential flow path that has allowed migration of the plume at a rate faster than the "average" flow rate for the aquitard. This type of flow system (**dual domain**) has been described in the literature, and should at least be mentioned here.

"Higher permeable portions"? Please state correctly.

114. Page 12, third paragraph states "*However, a large amount of the aquitard at the Site also consists of heterogeneous clays and silts (silty clay, sandy clay, silty sand, and clayey sand). Dissolved PCE in groundwater will move by advective transport and diffusion into the portions of these facies that have greater silt and sand content and where secondary porosity has developed along **soil partings** from **differential stress cracks** and **seasonal desiccation**. This inflow into the finer grained units may occur at rates of 1 to 20 ft or more each year. PCE in these silt and clay units may be retained for a very long time, as little degradation is evident from the monitoring data. Rebound of PCE into groundwater may occur from the diffusion of PCE that is **entrained** in these finer grained sediments after the application of many available remedial treatment technologies.*"

Please **rewrite this paragraph using standard geologic terminology**: "soil partings" is a (rarely used) term to describe the voids formed when peds form in a soil horizon. This term is not used in discussions of groundwater flow; "**differential stress cracks**" is a mechanical term generally used in materials science; "**seasonal desiccation**" is a term used to describe the condition of surface soils, not groundwater at 18 ft bgs. "Entrained" is used incorrectly and this sentence incorrectly states that this "entrainment" occurs "after the application of remedial treatment." This is probably not the meaning intended.

Section 5, Human Health Risk Assessment

115. Section 5 of the draft CAP is unacceptable.

Section 6, Identification of Preliminary Corrective Action Objectives and Remediation Standards

116. No minor comments on this section.

Section 7, Identification of Screening Technologies

117. **Extraction and Treatment.** Page 23, second paragraph states that "*The geology of the Site consists of interbedded **sequences** of sand, sandy silt, sandy clay, and silty clay with **frequent** zones of caliche and **intermixed** gravel **scattered throughout**. Heterogeneous **mixtures** of lower permeability clays and silts dominate the saturated **intervals** across most of the site. As presented in Section 2.2, **an alluvial stream-channel sand meanders** through the area of the former APTC facility and portions of the Boulevard Mall in the upper 1 to 5 ft of the saturated zone. In the central area of the site along the path of the plume, **sands exist** in the saturated lower portion of intervals screened by the wells. The geology of the well borings indicates that the sand intervals have limited lateral extent as typical of stream channel deposits. The change in facies from sand to silt and clay along the margin of the channel deposits create hydraulic boundaries **which limit the extent of the production or capture zone of wells**.*"

As previously stated (Sections 2.2 and 3.1), **please rewrite this description** using geologically correct terminology and precise language. "Sequence" has specific geologic meaning, not as used here; "mixtures" is not a technically correct description; etc.

Section 8, Development and Detailed Analysis of Alternatives

118. No minor comments on Section 8.

Section 9, Recommendations

119. No minor comments on Section 9.

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